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BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN
TROPICAL AGRICULTURE AND INDUSTRIES
AND THE COMMERCIAL UTILISATION OF
THE NATURAL RESOURCES OF THE
DOMINIONS, COLONIES AND INDIA

PREPARED BY THE SCIENTIFIC AND
TECHNICAL STAFF OF THE IMPERIAL
INSTITUTE, ASSISTED BY OTHER CONTRIBUTORS

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CONTENTS

PAGE

IMPERIAL INSTITUTE

GENERAL INFORMATION i

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

OCHNA PULCHRA FRUITS FROM RHODESIA 1

BALSA WOOD FROM BRITISH HONDURAS 4

MONKEY APPLE TIMBER FROM SIERRA LEONE . . . 8

SOME BRITISH HONDURAS WOODS AS PAPER-MAKING MATERIALS 12

INVESTIGATIONS AT THE IMPERIAL INSTITUTE OF SAMPLES OF PLANTATION PARA RUBBER PREPARED IN CONNECTION WITH THE CEYLON RUBBER RESEARCH SCHEME—VARIABILITY OF PLANTATION RUBBER—WITH APPENDIX ON METHODS OF TESTING 135

THE SEEDS OF *CITRULLUS VULGARIS* AS A SOURCE OF OIL 149

TANNING MATERIALS FROM TRAVANCORE 158

ECONOMIC PRODUCTS FROM DOMINICA:

1. CAMPHOR 275
2. GINGER 276
3. VANILLA 277
4. GOMMIER RESIN 278
5. COPRA 280

CONTENTS

PAGE
SUITABILITY OF CERTAIN NYASALAND CLAYS FOR THE MANUFACTURE OF BRICKS, TILES, DRAIN-PIPES AND POTTERY 281

INVESTIGATIONS OF ESSENTIAL OILS:

1. CAMPHOR LEAVES AND TWIGS FROM UGANDA . 421
2. MASSOI BARK FROM PAPUA 423
3. OIL OF *ORIGANUM MARU* FROM CYPRUS . . 426
4. MEDANG LOSOH OIL FROM THE FEDERATED MALAY STATES 428

DUGONG OIL FROM AUSTRALIA . . . 429

ARTICLES

HENEQUEN FIBRE OR MEXICAN SISAL HEMP . . . 17

CEMENT MANUFACTURE AND ITS POSSIBILITIES IN THE CROWN COLONIES AND PROTECTORATES. PARTS III AND IV 32, 431

BANANA CULTIVATION IN THE CANARY ISLANDS (with 8 illustrations) 168

THE PRODUCTION OF ALCOHOL FOR MOTOR FUEL FROM THE NIPA PALM IN NORTH BORNEO 175

CADMIUM: ITS OCCURRENCE, USES AND PRODUCTION . 181

THE CULTIVATION, PRODUCTION AND UTILISATION OF THE GROUND-NUT (with 5 illustrations) 291

NIGERIA: ITS DEVELOPMENT AND RESOURCES . . 331

NOTES

IMPERIAL INSTITUTE MONOGRAPHS ON MINERAL RESOURCES 47, 196

PLATINUM AND GOLD IN THE TRANSVAAL . . 48, 204

CEMENT TESTING: NEW MACHINE FOR COMPACTING CEMENT SAND BRIQUETTES 50

FORESTRY IN NORTH BORNEO 50

AGRICULTURE IN THE NETHERLAND EAST INDIES . 51

THE WORK OF THE UNITED STATES BUREAU OF PLANT INDUSTRY 55

NOTES—*continued*

PAGE
NEW COTTON PERIODICALS 57
SALE OF GOVERNMENT CROWN ESTATES IN WESTERN SAMOA 58
IMPERIAL INSTITUTE ACT, 1925 195
BRITISH EMPIRE EXHIBITION 196
CEYLON RUBBER RESEARCH SCHEME 197
MINERAL RESOURCES OF BRITISH SOMALILAND . . 200
NEW LIGNITE DEPOSITS IN NIGERIA 202
COTTON INDUSTRY OF INDIA 341
COTTON INDUSTRY OF INDO-CHINA 346
MINERAL RESOURCES OF ALBANIA AND MACEDONIA . 349
REORGANISATION OF THE IMPERIAL INSTITUTE . . 451
COTTON RESEARCH STATION FOR THE BRITISH EMPIRE 454
PULP-WOOD IN CANADA 455
INDIAN PULP AND PAPER INDUSTRIES 466
NEWFOUNDLAND COD-LIVER OIL 468
THE VEGETABLE OIL INDUSTRY OF THE PUNJAB . . 471
PORTLAND CEMENT. REVISED BRITISH STANDARD SPECIFICATION 472

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

FOODSTUFFS AND FODDERS 59, 205, 352, 473
OILS AND OIL SEEDS 63, 207, 357, 476
RUBBER 211
ESSENTIAL OILS 212, 356
FIBRES (INCLUDING COTTON) 71, 213, 361, 479
TANNING MATERIALS 84
MINERALS 86, 224, 368, 485

CONTENTS

PAGE

BIBLIOGRAPHY RELATING TO COLONIAL DEVELOPMENT AND RESOURCES 103, 246, 384, 503

NOTICES OF RECENT LITERATURE . 120, 265, 404, 522

BOOKS RECEIVED FOR NOTICE . . 133, 274, 419, 552

INDEX TO VOL. XXIII 553

LIST OF ILLUSTRATIONS

BANANA CULTIVATION IN THE CANARY ISLANDS

PL. FIG. FACING PAGE

I, 1. Reclamation of Land at Malpais, showing Retaining Wall with Water Conduit 168

I, 2. Bananas at Romolino on Terraces in a Ravine . . 168

II, 1. Banana Plantations at Argual Newly Planted with Old Stumps, showing Irrigation Channels . . 169

II, 2. Messrs. Fyffes' Packing House at Puerto de Santa Cruz, showing Graded Bananas 169

III, 1. Packing in Oblong Crates—Scene in one of Messrs. Fyffes' Packing Sheds 172

III, 2. Packing in Drums in one of Messrs. Fyffes' Packing Sheds 172

IV, 1. Building up Crates in one of Messrs. Fyffes' Packing Sheds 173

IV, 2. Landing Packing Material on Wharf at Las Palmas . 173

CULTIVATION OF THE GROUND-NUT

V, 1. Natives Thrashing Ground-nuts in the Gambia . . 304

V, 2. Screening Ground-nuts in the Gambia by Means of a Rotary Screen 304

VI, 1. Loading a Vessel with Ground-nuts in the Gambia . 305

VI, 2. Native Method of Winnowing Ground-nuts in the Gambia 305

VII, Exhibit of Ground-nuts and Ground-nut Products in the Gambia Court, Imperial Institute Galleries . . . 312

THE IMPERIAL INSTITUTE
OF THE
UNITED KINGDOM, THE COLONIES AND INDIA

THE Imperial Institute was founded, on the initiative of King Edward VII when Prince of Wales, as the Empire Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893. Its principal object is to promote the commercial and industrial utilisation of the raw materials of the Empire by systematic action in several directions, including the chemical and technical investigation of raw materials; the supply of information relating to such materials; and the maintenance of comprehensive exhibits illustrating the natural resources of all the countries of the Empire overseas. The work is organised in three main departments, viz., the Scientific and Technical Department, the Technical Information Bureau and the Public Exhibition Galleries, corresponding with the abovementioned subjects.

Scientific and Technical Department.—This Department possesses large and well-equipped laboratories in which raw materials from all parts of the Empire are investigated in order to determine their possible uses in industry. Special laboratories have been established for the examination of timber, rubber, cement, and ceramic materials, and complete technical trials of these materials can be carried out. A number of Technical Advisory Committees, including representatives of the trades or industries concerned with important groups of raw materials, such as timber, rubber, silk and minerals, co-operate in this work, and also assist by advising as to the possibility of utilising the materials examined and by suggesting subjects for investigation. The Institute is also in close touch with manufacturers and users of raw materials in this country and is thus able to arrange large-scale trials of promising materials when necessary and to obtain trial orders which may lead to the establishment of an export trade from the country of origin.

In most cases the materials examined are received from the Agricultural, Forestry, Mines and other Technical Departments in the Dominions, the Colonies and India; the agricultural products include those indigenous to the country, and also crops grown experimentally to determine their suitability for extended cultivation. Special analyses and investigations are also undertaken for firms or private persons in any part of the Empire on payment of appropriate fees. Application for such investigations should be made, in writing, to the Director.

For the convenience of enquirers, the Department maintains a Reference Sample Room in which are arranged samples of the principal raw materials investigated and valued commercially during recent years, and regarding which full information can be supplied.

Technical Information Bureau.—This forms the Intelligence Department of the Institute, and is responsible for dealing with enquiries for technical and commercial information respecting the production, utilisation and trade in the raw materials of the Empire.

The work of the Bureau is carried on in co-operation with the Scientific and Technical Department, and with the Public Exhibition Galleries, from which, when necessary, samples of products forming the subjects of enquiries are obtained. The Bureau is in communication with companies, firms, and trade and commercial associations in this country, who are in a position to supply special information, with official and other bodies concerned with technical questions, and also with the Agricultural and other Government Departments throughout the Empire.

The Bureau also undertakes the collection, indexing and arranging of such published and other information as is likely to be of service in dealing with the enquiries and in connection with other work of the Institute.

The enquiries are received from Governments, firms and individuals overseas, as well as from manufacturers, merchants and others in this country; while numbers of visitors to the Institute call to make specific verbal enquiries or to discuss special questions. Many of the enquiries from overseas have reference to the marketing of produce, while merchants and others in this country desire information as to supplies of raw materials from Empire sources. Another important section comprises requests for technical information regarding the details of industrial processes and particulars of the machinery involved therein; the methods of tropical agriculture and the processes adopted in the preparation of commercial products for the market; current conditions obtaining in the market as regards specific products; and related subjects. Other enquiries relate to the prospects for agricultural and other industries in the different countries of the Empire, chiefly in the tropics.

No charge is made for information supplied by the Bureau.

Publications.—The principal publication is the quarterly BULLETIN OF THE IMPERIAL INSTITUTE, which contains reports on investigations carried out by the Scientific and Technical Department; articles on the production, uses and marketing of raw materials; special sections dealing with recent progress in agricultural and mineral developments in different parts of the world; and notices of recent books and other publications, especially those relating to tropical agriculture and the development of natural resources.

A series of Handbooks to the Commercial Resources of the Tropics, with special reference to West Africa, has been issued, separate volumes being devoted to the Agricultural and Forest Products of British West Africa; Cocoa; Rubber; and Cotton and other Vegetable Fibres.

Minerals are dealt with in a series of Monographs, prepared under the direction of the Mineral Resources Committee of the Institute. These Monographs, of which twenty have so far been issued, draw attention to the sources of supply of important minerals within the Empire and in other countries, and give information respecting the commercial uses and value of the minerals.

The Reports of the Indian T[illegible] nquiry (seven volumes) discuss the possibilities of extending the use in the United Kingdom and other parts of the Empire of a number of important Indian raw materials. Other publications of the Institute include the series of Selected Reports from the Scientific and Technical Department, which contain the results of many technical and commercial investigations of Fibres; Gums and Resins; Food-stuffs; Rubber and Gutta-percha; and Oil-seeds, Oils, Fats and Waxes.

Library.—The Library of the Institute contains a large collection of works of reference, and is regularly supplied with the more important official publications and with many of the principal periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The Library includes about 35,000 publications, and in addition over 500 serial journals, etc., are regularly received.

A Reading Room is available for the use of enquirers and other visitors to the Institute.

Public Exhibition Galleries.—First among the objects of the Imperial Institute, as originally laid down, was "the formation and exhibition of collections representing the important raw materials and manufactured products of our Empire." At the present time between thirty and forty separate collections are maintained, each country of the Empire being represented; and new exhibits are frequently received from private sources as well as from the Governments concerned. The principal economic exhibits comprise food products (wheat, rice, maize and other cereals, tea, coffee, cocoa, sugar, fruits, spices, and condiments); fibres (cotton, jute, sisal, flax, hemp, etc.); gums, resins, rubber, oils and oil-seeds, timbers, tanning materials; animal products (wool, leather, feathers, tinned meats, oils and fats, shells, beeswax, etc.); and minerals. The Exhibition galleries, which are free to the public, thus provide under one roof a comprehensive permanent display of Imperial resources, and fulfil an important public purpose in teaching the commercial geography of the Empire. There is no other place where such collections, systematically arranged on a geographical basis, can be seen and studied side by side in one and the same building, with the assistance of maps, pictures, photographs, explanatory labels, diagrams and models.

Free lectures, with explanation of exhibits, are given to the public at stated times, and also to parties from schools on written application to the Director. Besides being visited by schools and the general public, the collections are used for reference purposes by commercial firms, and are also of value in connection with many enquiries and investigations conducted at the Imperial Institute.

Information relating to overseas countries and products is supplied to enquirers, and free literature is distributed from the Central Stand in the galleries, where also the publications of the Imperial Institute may be obtained.

The galleries are open free during the following hours: week-day, 10 a.m to 5 p.m. (4 p.m. in winter); Sundays, 2.30 to 6 p.m.

Ceylon Rubber Research Scheme.—In 1913 a scheme of research for the improvement of plantation rubber was established by the Ceylon Government and certain planting companies in the Colony in co-operation with the Imperial Institute, the general supervision being vested in Committees in Ceylon and in London. An independent scheme of rubber research was at that time conducted in the Colony by the Rubber Growers' Association. The existence of these two schemes involved some duplication of investigations, and in 1920 arrangements were made for their amalgamation. Under the new scheme, representatives of the Rubber Growers' Association were added to the Committee appointed by the Government of Ceylon to administer the scheme in the Colony, and also to the London Committee, which supervises the work carried out at the Imperial Institute. The London Committee includes a representative of the Research Association of

British Rubber and Tyre Manufacturers, with whom co-operation has been arranged in dealing with questions relating to raw rubber which require investigation.

The funds for carrying on the Scheme are provided by contributions from the Ceylon Government and the Rubber Growers' Association, and by subscriptions from planters and others connected with the rubber industry in the Colony who are not members of the Rubber Growers' Association.

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa.

Organisations accommodated at the Institute

Empire Forestry Association.—This Association, which is working in conjunction with the Imperial Institute Advisory Committee on Timbers, has been provided with office accommodation at the Imperial Institute.

Overseas Nursing Association.—An office has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

African Society.—This Society has its office at the Imperial Institute.

Northbrook Society.—This Society has been allotted accommodation for a Library and Reading Room adjacent to the Jehanghir Hall.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

OCHNA PULCHRA FRUITS FROM RHODESIA

A sample of the berries of *Ochna pulchra* was sent in 1924 by the Chief Chemist, Department of Agriculture, Southern Rhodesia, for examination. The berries had been found to contain a non-drying oil, and it was desired to ascertain the suitability of the oil for soap-making and other purposes.

Ochna pulchra is a tree of moderate size, indigenous to the Transvaal and Southern Rhodesia. According to information furnished by the Chief Chemist, the tree is plentiful on the Gusi sands, where it sometimes reaches a height of from 15 to 20 ft., and appears to do well on very poor soil. The trees are said to yield berries only every second or third year, all bearing trees fruiting together. The fruits mature from December to February.

The sample received at the Imperial Institute consisted of small kidney-shaped fruits, from 0·3 to 0·5 in. long and 0·25 to 0·35 in. in diameter. The fruits were separable into (*a*) "pericarp," the outer layer of which was oily and had an unpleasant odour, somewhat resembling that of valeric acid, and (*b*) a yellowish-brown kernel, which formed 43 per cent. of the entire fruit.

Character of Oil

For the purpose of chemical examination the fruits were separated into the two portions described above. The following yields of oil were obtained by extraction with light petroleum :

	Pericarp. *Per cent.*	Kernel. *Per cent.*
Moisture	8·0	7·2
Oil in original material	31·8	34·5
Oil expressed on moisture-free material	34·6	37·2

The pericarp oil was dark green, semi-solid, and had a strong odour resembling that of valeric acid.

The kernel oil was yellowish-brown, liquid, and contained a fair quantity of separated stearins. This oil had a very slight odour of the same nature as that of the pericarp oil.

The oils had the following constants :

		Pericarp oil.	Kernel oil.
Specific gravity at 100°/15° C.		0·8611	0·8615
Refractive index at 40° C.		1·459	1·460
Acid value		16·3	21·5
Saponification value		197·7	197·1
Iodine value (Hübl, 17 hrs.)	*per cent.*	58·5	74·3
Volatile acids, soluble		0·6	0·3
Volatile acids, insoluble		0·5	0·45

Character of Meal

The residual meal after the extraction of the oil from the pericarp was light brown in colour, with an odour resembling that of the pericarp and a slightly astringent taste.

The kernel meal was yellowish-brown, turning pinkish-brown on exposure to light ; it had a slight odour and very slight taste.

The meals were analysed with the following results :

	Pericarp meal.		Kernel meal.	
	As prepared.	Calculated for meal containing 7 per cent. of fat.	As prepared.	Calculated for meal containing 7 per cent. of fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·3	9·6	10·3	9·7
Proteins	7·3	6·8	21·3	20·0
Fat	0·5	7·0	0·8	7·0
Carbohydrates, etc. (by difference)	60·8	56·8	63·3	59·2
Crude fibre	18·8	17·6	2·1	2·0
Ash	2·3	2·2	2·2	2·1
Nutrient ratio	1 : 8·5	1 : 10·7	1 : 3·1	1 : 3·8
Food units	80	91	119	127

The pericarp meal was found to contain a slight amount of tannin, but neither meal contained any alkaloidal constituent.

The cake left after the expression of the oil from the entire fruits would have approximately the following composition, calculated from the composition of the residual meals from the pericarp and kernels :

	Per cent.
Moisture	9·6
Proteins	12·5
Fat	7·0
Carbohydrates, etc. (by difference)	57·8
Crude fibre	10·9
Ash	2·2
Nutrient ratio	1 : 5·9
Food units	107

Commercial Value

Both the pericarp and kernel oils should be suitable for soap manufacture, but it is not possible to state, without refining trials, whether either of them could be employed for edible purposes. The quantity of the oils available in the present instance was not sufficient for such trials.

The value of the oil for soap-making would probably not be more than about £45 per ton in the United Kingdom (November, 1924).

Feeding trials would have to be carried out with the meal before its general use could be recommended, especially in view of the fact that *Ochna pulchra* seeds are stated by Phillips to be poisonous (*Bothalia*, 1922, **1**, 91).

The pericarp meal has only a low feeding value, being poor in proteins and containing a considerable amount of fibre ; it also has a somewhat pronounced odour.

The kernel meal is of much better quality and compares favourably in composition with palm kernel meal, which realises about £9 per ton in the United Kingdom (November, 1924).

The cake from the entire fruits would have an unattractive odour, and the percentage of proteins would be rather small. The amount of fibre would be low for an undecorticated cake, but it would be necessary to ascertain by feeding trials that the husk present would not have any harmful effects.

General Conclusions

These *Ochna pulchra* fruits are of unattractive appearance and odour, but if they occur in sufficient quantity they might be utilised in South Africa as a source of oil. They would probably be difficult to dispose of in the United Kingdom.

It is unlikely that it would be feasible, in working on a commercial scale, to separate the fruits into pericarp and kernel, and the entire fruits would, therefore, have to be treated. The oils from the pericarp and kernel have similar constants, and the mixed oil could be utilised for soap-making. The mixed oil would possess the characteristic odour of the fruits, but this would probably not interfere with its use for the above purpose.

The value of the oil would be increased if an edible oil could be prepared from it by refining, but the amount of oil available at the Institute was insufficient for any experiments in this direction.

The cake left after the expression of the oil from the entire fruits could be utilised in South Africa as a feeding-stuff, preferably in conjunction with other materials, if feeding trials show that it is free from harmful effects.

BALSA WOOD FROM BRITISH HONDURAS

"Balsa" is the local name for a type of raft used in certain parts of tropical America, and any very light wood employed in its construction would appear to be known as "balsa" wood. One such is the West Indian cork-wood, derived from *Ochroma Lagopus* (Nat. Ord. Malvaceæ), a tree 30 to 70 ft. high, with a diameter of 1 to 2 ft., and occurring, either as the type form or as varieties (sometimes raised to specific rank), throughout the West Indies, Central America and the adjoining parts of South America. In addition to its use in raft-making, balsa wood, in its wide sense, is used for making floats for fishing nets, in the manufacture of life-belts and fenders for life-boats, and as a cork substitute for bottle stoppers.

The characters and working properties of balsa wood have recently been determined at the Imperial Institute, the material used being forwarded from British Honduras by the Conservator of Forests, who stated that it represented the lightest variety of the various balsa woods and is known locally as "Polak." The results of this investigation are given below. The wood has also been tested to ascertain its suitability for the manufacture of paper pulp (see p. 14).

The specimens received for examination consisted of (*a*) six planks, 5 ft. long and 2½ in. thick, cut from a log about 17 in. in diameter; and (*b*) a cross section, 6 in. thick, cut from the same log.

The wood was in sound condition, but two of the centre planks had split up the middle, and "checking" had commenced at the surfaces of the planks and cross section.

The log had a reddish-orange centre portion about 8 to 10 in. in diameter, whilst the outer wood was light orange-yellow with a number of greyish discolorations. The grain was generally straight, but there was some indication of an alternating spiral structure in places. The wood appeared to be short-fibred at the outside of the log and at the centre, but to have fibres of fair length at a radius of 3 to 5 in. The centre of the log, up to 3 in. in radius, was coarse, open, very soft, light, and of rapid growth, but the wood became harder, heavier and smoother towards the outside. The growth rings numbered from one to two per inch at the centre, and up to four per inch in the outer wood. Fairly numerous, orange-coloured, medium-sized resin ducts, partially filled, were distributed uniformly throughout the wood.

Results of Examination

A preliminary examination showed that the weight per cubic foot of the wood varied considerably, the outer wood being two to three times as heavy as that near the pith. This variation in weight was, therefore, carefully investigated with test pieces taken at varying distances from the centre of the log, which, as already stated, was 17 in. in diameter.

The results are shown in the following table, which includes the weight of the green wood and the amount of moisture present.

Specimen No.	Position of Test Piece.	Green wood.		Dry wood.
		Moisture.	Weight per cubic ft.	Weight per cubic ft.
		Per cent.	*lb.*	*lb.*
1	Within a radius of 3 in. from centre	58·0	11·7	7·4
2		48·2	10·9	7·4
3		37·4	14·0	10·2
4		41·7	14·6	10·3
5	Between 3 in. and 6 in. from centre	54·3	22·5	14·6
6		38·6	22·9	16·6
7		40·4	19·3	13·8
8		35·8	24·9	18·3
9		58·9	29·6	18·7
10		53·8	27·7	18·1
11		48·3	26·5	17·9
12		43·9	23·2	16·1
13		43·0	23·5	16·4
14		30·9	23·5	17·9
15		33·5	19·9	14·9
16	Between 6 in. from centre and the outside of log	16·9	25·0	21·5
17		18·6	23·7	20·0
18		15·4	23·8	20·7
19		15·6	25·5	22·0
20		15·3	26·3	22·8
21		17·8	27·7	23·5
22		16·1	28·6	24·6
23		18·3	24·9	21·0
24		14·2	26·3	23·1
25		23·0	25·1	20·5
26		26·8	25·4	20·0
27		23·8	25·3	20·4
28		18·4	24·0	20·3

These variations in weight may be summarised as follows:

	Average weight of dry wood.
Centre up to 3 in. radius	7½ lb. per cubic foot.
From 3 to 6 in. radius	16½ ,, ,, ,, ,,
From 6 in. radius to outside of log . .	21½ ,, ,, ,, ,,

The following table shows the volumetric shrinkage, on drying, of test pieces taken at varying distances from the pith:

Distance from pith.	Green wood.	Kiln-dried wood.		Dry wood.
	Moisture present.	Residual moisture.	Volumetric shrinkage.[1]	Volumetric shrinkage.
in.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
⅝ . . .	22·8	2·8	3·7	4·4
1⅛ . . .	21·5	3·4	2·4	4·0
2⅜ . . .	22·2	3·4	3·8	4·2
3¾ . . .	27·3	3·0	4·3	5·6
4⅛ . . .	25·0	3·1	4·4	5·8
5 . . .	23·8	3·1	5·6	7·0
5⅞ . . .	21·0	3·0	6·7	7·5
6¾ . . .	18·3	3·1	5·8	7·9
7⅝ . . .	16·2	3·0	5·0	5·9

[1] *After 70 hours drying at 40° C.*

These results show that the volumetric shrinkage increased from about 4 per cent. near the pith to a maximum of 7·9 per cent. at a radius of 6¾ in., and then decreased to 5·9 per cent. The warpage of the test pieces was in proportion to this shrinkage.

Results of Working Trials

(1) *Sawing.*—The wood cuts very easily with hand and power saws, but the fibres pull out badly, leaving a rough fibrous surface.

(2) *Planing.*—The fibres tend to pull out and foul the plane iron ; it is difficult to obtain a good surface with the soft inner wood, but the outer wood gives better results.

(3) *Boring.*—The soft inner wood tends to tear when bored with auger-bit, centre-bit or morse drill, but fairly good holes are obtainable with gimlet and bradawl. The harder wood behaves similarly on the whole, but gives clean holes with the auger-bit

(4) *Working with gouge and chisel.*—The wood can be cut fairly well along the grain, but the fibres tear out when it is cut across the grain.

(5) *Nailing and screwing.*—Nails and screws can be driven in readily and hold moderately well.

(6) *Turning.*—The wood turns easily ; the fibre bundles tear out badly, but with very sharp tools, small cut and sandpaper, a good finish is obtainable. There is very little difference in the turning properties of the softer and harder portions, except that the lathe centre pushes into the soft wood.

(7) *Polishing.*—Fairly satisfactory ; the polish soaks in readily.

(8) *Varnishing.*—The wood requires previous sizing. A fairly good surface is obtainable after several applications.

(9) *Glueing.*—Strong joints are obtainable as the wood absorbs the glue ; the failure of a glued joint occurs by the breaking of the wood.

(10) *Staining.*—The wood takes stains readily and well.

Remarks

The results of the investigation show that the weight per cubic foot of the wood varied widely according to its distance from the centre of the log. The inner wood was extremely light, weighing about 7½ lb. per cubic foot in the dry state, whereas the outer wood weighed 21½ lb. per cubic foot. Only the centre portion of this log would therefore be suitable for purposes for which a light corky wood is required.

It may, however, be mentioned that logs of balsa wood previously received from British Honduras have not shown this extreme variation in weight. A squared log of 10 in. diameter which was received from British Honduras in 1912, and was stated to be derived from *Ochroma Lagopus*, has been tested for comparison with the present specimen, and the weight per cubic foot of the dry wood varied only from 6·8 lb. near the centre to 10·8 lb. at the outside.

It is clear, therefore, that balsa wood does not always show the wide differences in weight exhibited by the present specimen. Such variations may possibly be related to the rapidity of growth of the tree, and it has been suggested that investigations might be made in British Honduras to ascertain whether "Polak" logs frequently exhibit marked differences in the weight per cubic foot of the wood.

MONKEY APPLE TIMBER FROM SIERRA LEONE

THE tree, *Anisophyllea laurina*, known in Sierra Leone as monkey apple, is a member of the Rhizophoraceæ; its Mendi name is Kanti. According to information supplied by the Commissioner of Lands and Forests, the tree is very common about seventy to ninety miles up the railway line from Freetown, and if a market could be found for the timber in this country, logs up to 3 and 3½ ft. in diameter could be supplied at the rate of from 50 to 100 per month.

A few hand specimens of the wood, supplied by the Commissioner of Lands and Forests, were examined by the Imperial Institute Advisory Committee on Timbers, who reported that the highly ornamental figure of the wood, which resembles that of New Zealand honeysuckle or rewa, might render it of value, but that its weight would probably militate against its use. In order that the commercial possibilities of the wood might be definitely ascertained, a consignment of ten logs was forwarded to the Institute in October, 1923.

After consultation with the Timbers Committee, arrangements were made with a firm of timber merchants to take charge of the consignment, and to cut up the logs into planks suitable for testing at the Imperial Institute and for submission to possible users.

The logs were found to be in poor condition on arrival, and showed numerous cracks, especially at the centre. They had also been considerably damaged by large wood-borers. The bark was ½ in. thick, greyish-brown, and very brittle.

Four centre planks were selected for testing at the Imperial Institute. They were very damp and checked badly even with careful seasoning.

The grain was straight and dense, with fairly short fibres.

In *transverse section* the wood was dark brown. The pores, which were not very numerous, were of medium size and usually partially filled. The rays were conspicuous against the dark brown ground tissues as gently undulating, light brown lines of varying width, seldom greater than 0·5 mm. The rings were indefinite, but were indicated by a fine darker line as boundary, due to a wider spacing between fine light concentric lines of soft tissue. They averaged seven to the inch.

In *radial section* the pores appeared as long, narrow grooves of light colour. The rays, which were very conspicuous, were seen as large, whitish-brown, dull flakes, sometimes over ½ in. broad, the ground tissue being lustrous orange-brown. The rings were vaguely indicated by dark narrow bands.

In *tangential section* the pores had the same appearance as in the radial section, whilst the rays were visible as dull, whitish-brown lines tapering at the ends and varying in length from ½ to ¾ in. The rings were shown by undulating, narrow, dark brown bands.

Results of Mechanical Tests

	Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :			
Maximum calculated longitudinal shear . . *lb./sq. in.*	502	419	470
Modulus of rupture . „	14,020	11,920	13,180
Fibre stress at elastic limit „	11,480	8,330	9,910
Modulus of elasticity . „	2,119,000	1,468,000	1,671,000
Elastic resilience . *inch-lb./cu. in.*	3·72	2·45	3·06
B.—*Compression test along the grain (24 in. length specimen)* :			
Crushing strength . *lb./sq. in.*	6,920	5,040	6,150
Fibre stress at elastic limit „	5,650	3,840	5,030
Modulus of elasticity . „	2,260,000	1,277,000	1,861,000
Elastic resilience . *inch-lb./cu. in.*	7·07	4·74	5·79
C.—*Compression test along the grain (8 in. length specimen)* :			
Crushing strength . *lb./sq. in.*	7,790	5,750	6,620
Fibre stress at elastic limit „	6,650	4,840	5,590
Modulus of elasticity . „	2,598,000	1,260,000	1,777,000
Elastic resilience . *inch-lb./cu. in.*	8·45	5·81	7·01
D.—*Compression test across the grain* :			
Load at elastic limit . *lb.*	9,700	4,600	7,150
Fibre stress at elastic limit *lb./sq. in.*	2,480	1,160	1,810
E.—*Shearing tests along the grain* :			
Radial—			
Maximum load supported *lb.*	5,050	4,010	4,380
Shearing strength . *lb./sq. in.*	1,320	1,040	1,130
Tangential—			
Maximum load supported *lb.*	8,260	7,000	7,370
Shearing strength . *lb./sq. in.*	2,130	1,850	1,930
Specific gravity	0·897	0·697	0·812
Weight per cubic foot . *lb.*	55·9	43·5	50·6
Moisture . . . . . *per cent.*	18·1	9·9	14·6

Results of Working Trials

(1) *Sawing.*—The wood cuts easily with hand and power saws.

(2) *Planing.*—It is rather difficult to plane, and there is a tendency for the broad rays to tear up when radial cut timber is planed.

(3) *Boring.*—Machine-boring tools cut easily and give clean holes, but hand tools, such as bradawls and gimlets, are difficult to use.

(4) *Working with gouge and chisel.*—It cuts fairly easily, but tends to chip.

(5) *Nailing and screwing.*—Nails and screws can be driven in with moderate facility and hold firmly.

(6) *Mortising and dovetailing.*—The wood cuts moder-

ately well in a mortising machine, and joints of good strength are obtainable. It splits rather easily.

(7) *Turning.*—The wood turns well, giving a fairly good surface with tools, and takes a good finish with sand-paper.

(8) *Polishing.*—The wood polishes well, but its ornamental figure is not then so apparent, owing to the reduction in contrast of the colours of the rays and ground.

(9) *Varnishing.*—Good results are obtained.

(10) *Glueing.*—The wood does not absorb glue readily, but moderately strong joints are obtainable.

(11) *Staining.*—It takes stain satisfactorily.

Commercial Possibilities

As already mentioned, the Timbers Committee of the Imperial Institute inspected the hand specimens of Monkey Apple wood which were first forwarded and expressed the opinion that it might be of value for ornamental purposes if the weight were not too great. It was subsequently found at the Institute that the wood has a great tendency to check even when carefully dried, and this would be a serious drawback to its use.

A number of enquiries as to the commercial possibilities of the wood have, however, been made. The timber merchants who took charge of the logs undertook to bring the wood to the notice of their customers, and the Imperial Institute supplied specimens for trial to manufacturers of furniture and brushes. As a result the following reports were obtained.

The timber merchants express very strong doubts as to whether Monkey Apple wood will find a market in this country ; they are definitely of opinion that the timber will not be accepted for general use, although it might be suitable for small special purposes. In these circumstances firms in this country would not be prepared to devote time and attention in endeavouring to find such a purpose, and would not stock the timber against possible sales.

One of the largest companies manufacturing furniture, after carefully examining the wood, reported that it was too heavy and dense for their purposes. This opinion was confirmed by two other important firms in the trade who were also consulted.

Samples were also submitted to brush manufacturers, who stated that the wood is much too heavy for the class of brushes for which it would have to be used, and that its liability to split in manufacture would prevent it from "making up" satisfactorily for brush backs.

The Timbers Committee concur in the opinions of these firms. They point out that Monkey Apple would appear to be an example of the large number of apparently attractive timbers which from time to time have been sent to this country, but have failed to find a market.

Remarks

Monkey Apple is a fairly heavy and moderately hard wood of excellent decorative appearance, owing to its striking "silver grain." It works fairly easily with most machine and hand tools, and finishes well. It has good strength in transverse bending and compression, and is fairly stiff. Its tangential shear strength is nearly twice that of the radial on account of the weakening effect of its large medullary rays.

The susceptibility of the wood to bad shakes (judging from the logs forwarded) and its readiness to "check" are serious drawbacks to its use. In addition its weight renders it unsuitable for furniture manufacture.

The commercial possibilities of Monkey Apple wood in this country are therefore not promising.

SOME BRITISH HONDURAS WOODS AS PAPER-MAKING MATERIALS

THE three woods which are the subject of this report were examined at the Imperial Institute in the course of an investigation of British Honduras timbers, and reports were furnished to the Government as to their characters and possible value as timbers (see this BULLETIN, 1924, **22**, 401, 406 and this number, p. 4). It was subsequently suggested by the Conservator of Forests that the trees might be worth cultivating in certain places on a short rotation as sources of paper-pulp, and the Imperial Institute was requested to consider the suitability of the woods for this purpose.

Laboratory trials have accordingly been made with the three woods and the results are given in the following report. In each case the wood was treated with caustic soda, under conditions similar to those employed for the production of paper-pulp on a commercial scale.

QUAM WOOD (*SCHIZOLOBIUM* SP.)

The wood was chemically examined with the following results :

	Per cent.
Moisture	10·8
Ash	1·0
Cellulose in material as received	52·4
Cellulose expressed on the moisture-free wood	58·7

The ultimate fibres measured from 0·5 to 1·7 mm. in length, with an average of 1·2 mm.

Results of Paper-making Trials

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp expressed on wood as received.	
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
		Hours.	° *C.*		*Per cent.*	*Per cent.*
20	4	6	160	11·0	47	42

The above treatment gave a good yield of well-reduced pulp, which yielded a rather soft, light brown paper of fair quality. On bleaching, the pulp furnished a pale cream, opaque paper of fairly good strength.

Quam wood is fairly well adapted for paper-making, giving a good yield of pulp with moderate consumption of soda. The pulp, although rather short-fibred, is somewhat similar in character to commercial poplar pulp and furnishes paper of fairly good strength.

WHITE MOHO (*HIBISCUS* SP.)

The wood was chemically examined with the following results :

	Per cent.
Moisture	8·5
Ash	0·5
Cellulose in material as received	52·2
Cellulose expressed on the moisture-free wood	57·0

The ultimate fibres measured from 0·8 to 2·3 mm. in length, with an average of 1·6 mm.

Results of Paper-making Trials

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp expressed on wood as received.	
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
			Hours.	*° C.*		*Per cent.*	*Per cent.*
A	16	3½	6	150	—	—	—
B	16	3½	6	160	12·0	52	48
C	20	4	6	160	12·7	46	41

The conditions of trial A were not sufficiently drastic to enable the material to be converted into pulp. The product obtained in trial B also proved to be insufficiently treated and yielded pulp showing many particles of incompletely disintegrated material. This pulp furnished a rather hard, dark brown paper, which was tough and resistant. Even a strong bleaching treatment only reduced the colour of the pulp to a pale brown tint, and the paper produced contained numerous dark-coloured particles.

Trial C afforded entirely satisfactory results and furnished a pale brown pulp of good strength and quality, which bleached readily and gave a strong, almost white paper.

These results show that White Moho will give, on suitable treatment, a good yield of pulp consisting of fibres of fairly good length. The pulp is firm and tough, felts well and furnishes strong opaque paper.

POLAK (*OCHROMA LAGOPUS?*)

The specimens of this wood supplied to the Imperial Institute varied considerably in hardness and weight, the centre portion of the logs being soft and light and the outer portions much harder and heavier (see page 5).

The proportion of soft wood in the sample examined was about 17 per cent. by volume, or 10 per cent. by weight. The soft and hard portions were each chemically examined, with the following results :

	Hard wood. *Per cent.*	Soft wood. *Per cent.*
Moisture	9·3	8·6
Ash	0·8	1·0
Cellulose in material as received	48·9	47·4
Cellulose expressed on the moisture-free wood	53·9	51·9

The ultimate fibres of the hard wood measured from 0·5 to 3·0 mm. in length, with an average of 1·8 mm., and those of the soft wood from 0·7 to 2·1 mm. with an average of 1·6 mm.

Results of Paper-making Trials

The soft and hard portions were separately treated.

Hard Wood

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp expressed on wood as received.	
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
		Hours.	° C.		*Per cent.*	*Per cent.*
20	4	6	160	13·2	45	42

These conditions proved just sufficiently vigorous to break up the material fairly satisfactorily. The pulp produced a light brown paper of good strength, but containing many specks. It bleached readily to a cream colour, furnishing a paper free from specks of non-disintegrated material, and of good strength.

Soft Wood

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp expressed on wood as received.	
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
			Hours.	° C.		*Per cent.*	*Per cent.*
B	20	3	6	160	13·8	55	—
C	24	3½	6	160	15·9	54	—
D	30	4	7	160	17·0	43	39

Trial B gave a strong but not fully disintegrated pulp, furnishing a hard and rather "rattly" brown paper of good strength and toughness. The pulp would not bleach satisfactorily.

The pulp produced by the somewhat more drastic treatment of trial C was of similar quality, and still contained much non-disintegrated material. On bleaching the pulp furnished a pale brown paper containing many specks, but of good strength.

Trial D produced a well-reduced pulp, bleaching readily and furnishing hard, tough, white paper, which, however, was rather transparent and parchment-like.

The foregoing results show that the hard portion of this Polak wood is very suitable for paper-making, giving a fairly high yield of bleached pulp which furnished white paper of good strength and quality. The soft portion of the wood, however, is not so satisfactory, as it requires a larger quantity of soda for its conversion into pulp, and the parchment-like character of the bleached pulp is a disadvantage for the production of ordinary types of paper. It would, however, be impracticable to separate the two portions for pulping on a commercial scale.

On the whole, Polak wood will furnish a fairly satisfactory paper-pulp, but the nature of the product will depend to some extent on the relative proportions of hard and soft wood present, which may vary considerably in different logs. The presence of a large proportion of the soft wood would lead to the production of a paper inferior in quality to that obtainable from timber in which the hard wood predominates, and would, moreover, increase the cost of manufacture of the pulp owing to the larger consumption of soda entailed.

In general, the unbleached pulp obtainable from the whole logs would be suitable for the manufacture of a strong wrapping paper, whilst the bleached product would furnish a white paper of fair quality.

General Remarks

The results of the investigation of these three timbers indicate that, when treated under suitable conditions, Quam wood and White Moho give satisfactory yields of pulp of good strength and quality. The former can be reduced with a rather smaller consumption of soda than the latter, but, on the other hand, the White Moho pulp is composed of somewhat longer fibre than the Quam wood pulp, is of rather better quality, and is more easily bleached. Both pulps would furnish paper of satisfactory quality.

The Polak wood presents a difficulty owing to the variation in density in different parts of the trunk, which apparently does not occur to the same degree in all the trees. In the report on the characters and working qualities of Balsa (Polak) wood (see p. 4), it was suggested that investigations should be made in British Honduras regarding the differences in the density of the wood of Polak logs. If as the result of such investigations any considerable variations of this kind are found, it would be well for comparative paper-making trials to be made with further specimens.

In the case of the present specimen of Polak wood, the proportion of soft wood is not sufficient to cause any marked inferiority in the paper made from the entire log as compared with that prepared from the harder portion only.

ARTICLES

HENEQUEN FIBRE OR MEXICAN SISAL HEMP

In an article on the " Present Position of Sisal Hemp Cultivation, with Special Reference to the British Empire " (this Bulletin, 1924, **22**, 39), mention was made of the fibre produced in Yucatan, Mexico, from the leaves of *Agave fourcroydes*, Lem. (*A. rigida*, Miller, var. *elongata*, Jacobi), which is commonly termed " Henequen " or " Mexican Sisal."

In view of the increasing importance of Sisal hemp cultivation in Kenya, Tanganyika and other parts of the British Empire, it has been suggested that a short account of the Mexican henequen industry would be of interest to British producers, and the following article has, therefore, been compiled. Numerous publications have been consulted, and information has been drawn in particular from reports specially obtained for the Imperial Institute by the Department of Overseas Trade from H.M. Consul at

Merida, the Chamber of Commerce of the same town, and the British Embassy at Washington, and from *Department Bulletin* No. 1278 (1924), *U.S. Department of Agriculture*, entitled "Production of Henequen Fibre in Yucatan and Campeche," by H. T. Edwards. The last-mentioned report is based on field investigations made by Mr. Edwards in Yucatan and Campeachy in 1923.

The henequen plant is widely distributed in Yucatan and Campeachy, the principal area of fibre production being a region extending for about 60 miles south of Progreso and the same distance east of Progreso and Merida. One of the largest and most prosperous districts is that in the vicinity of the town of Motul, about 30 miles north-east of Merida. Henequen is also grown in considerable quantities on the lands between Merida and Progreso, and there are a number of large plantations to the south of Merida. Much land on both sides of the railway between Merida and Temax is devoted to henequen, and the plant also grows to the north, between Temax and the sea, and occurs in the wild state along the sea-coast east of Progreso and north of Merida, Motul and Temax.

The first attempt to produce the fibre on a commercial scale was made in 1839. The fibre was extracted from the leaves by means of native implements, and was afterwards packed in loose bales, of about 200 lb. each, and sent to New York. It found a market, but the production was barely remunerative. The methods of cleaning the fibre were so slow that, even with the cheap labour of that time, the cost of preparation was so high as to be discouraging. The State Government, realising the great need of a suitable machine to clean fibre, offered a prize of 10,000 Mexican dollars to the inventor of an apparatus, capable of producing a certain output per hour. The result of this offer was the invention of the "raspador" machine (see page 24) by a Franciscan friar.

The production of henequen fibre is now the chief industry of Yucatan, the value of the exports being about 85 per cent. of that of the total exports of the State.

The Plant and its Varieties.—The henequen plant has a short trunk bearing a number of thick fleshy leaves, usually from 4 to 5½ feet in length, which bear marginal thorns, and a sharp, horny, terminal spine. At a certain age, which varies in Yucatan from fifteen to thirty years, the plant, like other species of Agave, throws up a " pole " or flowering stem, 20 to 30 feet high. The flowers are produced in dense clusters at the ends of short lateral branches and, after they have begun to wither, buds appear in the axils of the flower-stalks. From these buds arise small plants, known as " bulbils," which grow to the length of a few inches, and then fall to the ground, where, under suitable conditions, they take root. After the production of the bulbils, the whole plant withers and dies.

According to Edwards, eight varieties of henequen plant are recognised, but considerable confusion exists concerning them, as the same variety may bear different names in different districts, or different varieties may be given the same name in different localities. The three varieties most extensively cultivated are the " sac-cí," " chucún-ci " and " quintán-ci," many of the large plantations containing plants of all these varieties. Edwards gives the following particulars:

" The sac-cí variety is planted more extensively than all others combined. It is of medium size, the trunk when fully developed being from 4 to 5 feet in height. The leaves are bluish grey in colour, from 4½ to 5 feet in length, and from 3½ to 4 inches in width. Under favourable conditions this plant lives from twenty-five to thirty years, and produces from twenty to thirty leaves per annum. The fibre obtained from this variety is relatively coarse, strong, and white, and the yield is large.

" The chucún-ci variety, which is also widely planted, differs somewhat in appearance from the sac-cí. The leaves of the chucún-ci are broader and of a more pronounced greenish colour, and are also somewhat marked with small brownish spots. This variety matures more slowly than the other, but lives rather longer. The fibre is relatively short, but coarse and heavy. The yield of fibre is said to be a little less than that of the sac-cí.

" The quintán-ci, which closely resembles the chucún-ci, produces fibre of excellent quality, but the yield is somewhat less than that of the varieties previously mentioned."

The name "yax-cí," applied to a certain variety of henequen, is also used in Yucatan to designate the sisal plant, *Agave sisalana,* whilst "cahún-ci," the name of another variety, is sometimes employed for *Furcræa cahum.*

Climate and Soil.—The henequen plant is particularly well adapted to the tropical conditions which obtain in the north of Yucatan. It is not adversely affected by hot seasons ; in fact, the heat of the sun, especially when accompanied by humidity, appears to act beneficially. An unusually protracted drought may retard the development of the plant, and impair the quality of the fibre, but does not permanently affect the growth of a healthy well-rooted plant. The plant is not injured to any great extent by rainy seasons, and it is not seriously affected by a fall in the temperature ; the lowest temperature recorded in Yucatan is 48° F.

The land on which henequen is produced in Yucatan is of a very rocky character, and consists of a porous, partially decomposed limestone with numerous pockets, and in some places is coated with a thin layer of fertile soil. Such land, although quite unsuitable for the cultivation of any other crop, is excellent for henequen. Experience has shown that fibre grown on soil of this class has a greater tensile strength than that produced on richer land, although in the latter case the fibre tends to be longer and more flexible.

In Campeachy the soil is less rocky and more fertile than in Yucatan. The henequen plants therefore grow more rapidly and luxuriantly, but the weeds and brush are also more prolific.

Cultivation.—The plant can be propagated by means of seed, bulbils (or "pole plants" borne on the flowering stem), or suckers or scions. The first-mentioned method is never practised now, since very few of the seeds are fertile, and much time is lost in raising the seedlings. There is a strong objection to the use of bulbils, as they have to be grown in a nursery for one or two years, and conditions in Yucatan are unfavourable for nursery work, there being very few localities where there is sufficient good soil for the purpose. Moreover, it is considered by the planters that plants grown from bulbils in Yucatan are not so strong or long-lived as plants grown from suckers. Propagation is, therefore, almost invariably by means of suckers.

In preparing land for planting, the undergrowth is cut down, allowed to dry, and then burned. The ground is not ploughed or harrowed. Shortly before the rainy season commences, the young suckers which have appeared under the shelter of the parent plant are uprooted and planted out in rows. In the opinion of Mr. Manuel A. Torre (a native hemp farmer of Yucatan) the best size of the shoots for planting is about 2 feet (not including the bulb). Some planters hold the view that shoots of 18 inches are preferable, as they consider that the plants then continue to produce for a longer period. Mr. Torre, however, regards this as a mistake, and contends that the only difference is that the plants from the 18-inch suckers take a longer time to reach full development.

The suckers are sometimes planted at once after being uprooted, or in some cases as much as two or three months is allowed to elapse. Fairly prompt planting, however, is considered advisable. At one time the suckers were planted at a distance of 2 yards from one another, but it is now usual to space them in such a way that they form rows about 4 yards apart, with 1½ yards between successive plants in the row. This arrangement gives about 900 plants to the acre. Sometimes a closer spacing is adopted, allowing 1,000 to 1,200 plants per acre. The rows are generally made to run from east to west in order that the plants may get as much sunshine as possible, and also on account of the prevailing winds.

The suckers are planted in small holes, prepared in advance, and the bulb is partly covered with earth. If the land is very rocky, and but little soil is available, the suckers are commonly propped up with small stones. Plants which fail to grow are replaced with new suckers. The plantations receive but little treatment subsequently, except that they are usually roughly weeded once every six months during the first three years, and every eight or twelve months afterwards.

The weeds and brush are deposited between the rows, where they gradually become dry, and in plantations in which they are allowed to accumulate they are liable to cause serious losses by fire. This is a danger which must be carefully guarded against, and is apt to occur if a spark is allowed to fall on a badly cleaned field. The resulting conflagration of the dry vegetable rubbish is fatally injurious to the roots of the plant. About 14,000 acres of henequen were destroyed in this way during 1922, and about 7,000 acres during the dry season of 1923. Organised efforts have been made recently to clean all the neglected plantations, and it is probable that this will reduce such losses in future.

Pests.—Another danger to which the plant is liable is that of attack by a large black beetle (*Scypophorus acupunctatus*), known to the natives as the " max." The female insect lays its eggs on the trunk of the plant at a point a few inches above the ground. When hatched, the larva bores through the outer bark into the interior and, generally taking an upward direction, burrows from 6 to 12 inches. When fully grown, it works its way to the bark, where it changes to a pupa and so remains for some months. Finally the beetle emerges, leaving the plant injured and weakened, and sometimes killed. It is sometimes destroyed with Paris green or with petrol, but is best controlled by keeping the plantations clean and free from old stumps and other refuse.

In some districts, considerable damage is caused by a small rat-like animal, the " tuza," which burrows in the ground and destroys the plants by gnawing the roots. Several methods have been suggested for destroying this animal, including the introduction of carbon disulphide into the burrows, and poisoning with bait containing arsenic or strychnine.

Harvesting.—The time required for a plantation to reach the producing stage depends on the variety of plant which is grown, the quality of the land, and the amount of care exercised in cultivation, and varies from five to twelve years. The plants generally reach maturity about five, six or seven years after being set out, and those leaves which are ready for cutting then begin to extend laterally at right angles to the trunk. The leaves should be cut soon after this condition has been reached or otherwise they deteriorate in quality. Over-cutting must be avoided as it weakens the plant and impairs the quality of the fibre.

Most planters harvest all the year round, but in some districts no leaves are cut in May, June and July, as they are then too hard for satisfactory treatment by the extraction machine. On the best managed plantations, only two cuttings are usually made per annum, and there are some localities where only one cutting is made each year.

Harvesting is effected by means of a heavy knife with a hooked end, which is termed the " corba " or " machete." The native cutters throng the field and deftly cut the leaves close to the trunks, trim off the thorns at the sides and snip off the terminal spine, and then bind the leaves in bundles of forty or fifty. On the larger plantations, the bundles are conveyed by railway to the fibre mill.

The yield of fibre depends on the variety of the henequen agave grown, the spacing of the plants in the plantation, and the local conditions. In general, leaves can be cut from the same plant for fifteen to twenty years to the number of about twenty to thirty per annum, twenty-five being considered a fair average. The fresh leaves yield from 4 to 5 per cent. of their weight of dry fibre and the average annual production amounts to about 1,000–1,200 lb. per acre.

Extraction of Fibre.—The fibre is now usually extracted by means of machinery, but an interesting account was given some years ago by the United States Consul at Progreso of a method in which primitive native implements, the " pacche " and " tonkas," were employed. The " pacche " is a long, wooden bar, triangular in section, with sharpened edges, and provided with rounded ends, which serve as handles. The end of a leaf is fixed by means of a peg into a hole on the flattened surface of a log of wood : the " pacche " is then pushed away from the operator over the surface of the leaf, and by this scraping process the pulp is gradually removed from the fibre. The " tonkas " is a hard, wooden knife, about 18 inches long and 5 inches wide. At its upper edge it is about an inch thick, but it gradually becomes thinner, the lower edge being thin and sharp and curving inwards. The fixed table has a curved surface corresponding to that of the edge of the instrument. The leaf is placed between the table and the " tonkas," and the latter is held firmly with one hand, whilst with the other hand the leaf is drawn sharply towards the operator. The " pacche " has continued to be used to some extent by the natives of the interior of Yucatan, and by its means one worker can produce from 6 to 9 lb. of fibre per day. It is said that the fibre prepared in this primitive manner possesses qualities which are not present in the machine-cleaned product, and that the makers of the finest hammocks in Yucatan will not use a fibre prepared by any other method.

The invention of the " raspador " machine inaugurated a new era in the commerce of Yucatan. It was found that with the aid of this machine two men could prepare more fibre than forty could with the " pacche " and " tonkas " and, in consequence, henequen farms began to multiply and become prosperous.

The following description of the " raspador," by a correspondent of the *Syracuse Herald* in Yucatan, is quoted by C. R. Dodge in *Report No.* 3 (1891), *Fibre Investigations, Division of Statistics, U.S. Dept. Agric.*:

" It is simply a wheel, like a 4-foot pulley, 6-inch face, with pieces of brass an inch square and 6 inches long running across the face, about a foot apart. This wheel runs in a heavy wooden case. When working well it makes about 110 revolutions a minute. The leaf is put in through a small hole in the case, and being held by a strong clamp, is allowed to whip downward as the wheel revolves. A heavy block, like the brake of a car wheel, is, by lever, brought to bear on the leaf, pressing it against the revolving wheel. In a second the pulp is crushed and thrown into a pit under the wheel, and the fibre is drawn back, one-half of the leaf being cleaned more quickly than one can follow the motions. The leaf is reversed, and the other end cleaned in the same manner."

The modern method of preparing henequen fibre from the leaves is described as follows by Edwards in the

Bulletin of the United States Department of Agriculture, to which reference has already been made (page 18).

" When the leaves arrive at the mill, the bundles are placed on carriers, which deposit them on the feeding table at the rear of the cleaning machine. There are usually three men working at the feeding table, one of whom opens the bundles, one arranges the leaves on the table, and one feeds the leaves into the machine. No effort is made to sort the leaves according to size, though on some of the plantations the damaged leaves are thrown out at the feeding table.

"The machines used for cleaning the fibre are different types of the 'Prieto' and the 'Pascal' with an occasional 'Mola.' The capacity of these different machines varies from 10,000 to 20,000 leaves per hour, the larger ones cleaning from 150,000 to 200,000 leaves in a day; but all of them operate on the same general principle.

" The leaves are fed sidewise in a continuous row into the machine. Each leaf is held near the centre as it is carried forward past a rapidly revolving scraping wheel, which removes the pulp from half of the leaf. The grasping device then shifts to the cleaned fibre, and a scraping wheel on the opposite side of the machine cleans the other half of the leaf. At each scraping wheel a small stream of water runs over the clean fibre. The machines are operated on an elevated platform, in order that the large quantity of waste may fall directly into dump cars, that are run under the machine. As the cleaned wet fibre leaves the machine, it is assembled in small bundles and slid down an inclined pole to a workman standing on the ground."

The disposal of the enormous quantity of leaf refuse produced in the extraction of the fibre is a matter involving considerable expense. The waste as it leaves the machines is loaded into cars and conveyed by a plantation railway to a dump in an adjacent field. Although attempts have been made to utilise the waste for the manufacture of paper, alcohol, etc. (see this BULLETIN, 1915, **13**, 445), it is not at present being employed for any purpose on a commercial scale.

Immediately after being extracted, the fibre is conveyed from the machine to the drying ground where it is hung on lines of galvanised iron wire stretched between upright posts, and is left exposed to the sun until dry. It is then taken to the warehouse and packed in bales, varying in weight from 352 to 396 lb. Five different grades are recognised, depending chiefly on the colour of the fibre and its freedom from pulpy matter of the leaves, which adheres to it when the cleaning has been inefficiently performed.

Henequen fibre is usually more brittle and less flexible than East African sisal hemp, and is also less regular and neither so white nor so well cleaned.

Cost of Production.—Owing to the great variation existing in the local conditions and the cost of labour in different parts of Yucatan, it is difficult to obtain satisfactory data regarding the costs of production.

Edwards refers to estimates by two different planters, showing the total cost of production as 2·6 cents (1·3*d.*) and 3 cents (1½*d.*) per lb. respectively. He also states that the opinion is held that a grower who receives 3½ cents (1¾*d.*) per lb. for the fibre can keep his plantations in good condition and prepare the fibre at a small profit, but that such profits are insufficient to provide for the establishment of new plantations.

More detailed information regarding the costs of production, supplied by Mr. Manuel A. Torre in 1921, is printed as an appendix (page 29).[1]

Production and Exports.—In 1924, the Comision Exportadora de Yucatan reported that there were 1,164 henequen plantations in the State and estimated the total area devoted to the crop as about 551,000 acres, of which about 141,000 acres were bearing plants at the cutting stage.

According to returns issued by the Comision Exportadora, the total numbers of bales of fibre (of average weight about 375 lb.) produced during the years 1912–1923 were as follows :

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[1] The figures given by Mr. Torre must be regarded merely as an indication of the conditions existing in 1921, and not as being necessarily accurate at the present time.

Year.	Bales.	Year.	Bales.
1912	814,610	1918	768,723
1913	836,950	1919	664,972
1914	964,862	1920	953,034
1915	949,639	1921	626,980
1916	1,191,433	1922	434,036
1917	733,832	1923	612,745

Most of the fibre is exported to the United States. The amount entering that country was 93 per cent. of the total exports in 1911–12, 91 per cent. in 1912–13, and over 99 per cent. in 1919.

According to the *Report on the Economic and Financial Conditions in Mexico*, by H.M. Consul-General, Mexico City, issued in 1924 by the Department of Overseas Trade, the exports for the year ended August 31, 1923, amounted to 547,487 bales, of which 525,004 were from Yucatan and 22,483 from Campeachy. The destinations of these shipments are shown in the following table :

Country.	No. of bales.	Country.	No. of bales.
United States	400,042	Belgium	11,811
Great Britain	18,452	Spain	694
France	75,879	Portugal	173
Germany	7,001	Mexico	902
Italy	416	Argentine	1,367
Sweden	14,073	Brazil	606
Norway	27	Uruguay	1
Holland	8,044	Cuba	7,999

The quantities imported into the United Kingdom from Mexico in the years 1919–1924 were as follows : 1919, nil ; 1920, 1 ton ; 1921, 532 tons ; 1922, 237 tons ; 1923, 158 tons ; 1924, 885 tons. The value of the imports in 1924 amounted to £36,124.

Present Position of the Industry.—During recent years the henequen industry of Mexico has been in a somewhat unstable condition, owing to political disturbances and the disorganisation of the market.

Between 1896 and 1900 the industry came under the complete control of American interests. Large profits were made by refusing to buy from the producers until they had accumulated large stocks and were on the verge of ruin, when they were forced to sell at extremely low prices. Eventually the planters' grievances became so acute that the Government established the Comision Reguladora del Mercado de Henequen, with the object of controlling and regulating the industry. In 1915 this organisation entered into five-year contracts with the growers on a so-called profit-sharing basis. All the fibre produced was to be delivered to the Comision, which fixed prices to both producers and buyers, and retained a large share of the profits. The Comision controlled the railway service, and restricted the use of its freight cars to their own consumers. Duties were imposed on the exports, railway freights and warehouse charges were enormously increased, and the industry became practically a Government monopoly.

The price of the fibre was artificially increased, with the result that the demand fell off. In consequence of this, the Comision Reguladora amassed enormous stocks (amounting at one time to no less than 800,000 bales) which eventually had to be sold at a greatly reduced price. Owing to this fall in price, many of the planters had to work at a loss ; the plantations were neglected, and the output of fibre rapidly decreased.

On account of these circumstances and of entanglements in other directions, the Comision Reguladora was unable to meet its obligations, and had to suspend business operations. By the beginning of 1921 it was bankrupt, many of the planters had become ruined, and the industry badly disorganised, whilst large surplus stocks of fibre were in the hands of Americans. The situation grew steadily worse, and early in 1922 the Government established the Comision Exportadora de Yucatan, but this apparently was not very different, except in name, from the older Comision. The growers still failed to receive their fair share of the proceeds of their crops and towards the end of the year they refused to deal with the organisation. In order to prevent it from sharing the fate of the Comision Reguladora, an American selling agency (the Sisal Sales Corporation), came to its assistance. The Corporation lent the Comision Exportadora large sums of money for loans to the planters to enable them to clean their plantations and increase the output, and it attempted to force growers to deal with it through the Comision. Attempts were made by the planters to defy this combination, but without success, and as an outcome the production again fell considerably and replanting was neglected.

At the beginning of November, 1924, about 86 per cent. of the growers united in the Co-operative Association of Henequen Planters in order to eliminate the costly interference of the Comision Exportadora and the Sisal Sales Corporation which, the planters stated, " has ruined our henequen fields, decreasing our production and threatening the total extinction of henequen plantations." It was subsequently reported that large American twine spinners had made arrangements for the purchase of their requirements from the new Co-operative Association, and that substantial quantities of fibre had already been secured.

Towards the end of December, however, it was announced that the Comision Exportadora had revived its activities and was again purchasing the fibre. It was also reported that the Co-operative Association was about to suspend operations, as a number of planters had decided to withdraw from it, thus bringing the total production represented by the membership below the legal minimum required for its existence.

In the report of H.M. Consul-General, to which reference has already been made, the opinion is expressed that in order for Yucatan to regain its prosperity, the amount of hemp sold annually (on the basis of present prices) must be at least 800,000 bales. Two large companies in the United States purchase about 700,000 bales a year and efforts have been made in the past year to find an increased outlet in Europe. It is stated, however, that no great success has been obtained on account of the competition of East African sisal, and other classes of fibre.

APPENDIX

Information furnished by Manuel A. Torre in July, 1921, *regarding the cost of production of henequen fibre at that time* (*see footnote, page* 26).

THE value of a " mecate " of land (approximately one-tenth of an acre) suitable for henequen, varies according to the distance of the land from the pu existing plantations, the quality of the land, and r fuel can be cut on the land or whether it has already been cleared. If the land in question is the property of the seller it may be estimated at 1 peso[1] the mecate if it contains bush to yield fuel, but only at 25 cents Mexican money if the land is already cleared, or what is commonly called "pocche." If the land has to be purchased from a third party, its value fluctuates between 1 peso and 1 peso 50 cents in the first case, and between 50 cents and 1 peso in the second case.

The cost, per mecate, to clear the land for planting henequen is from 1 peso to 1 peso 50 cents if the scrub remains, and from 50 to 75 cents if the land has been cleared.

The cost of preparing the ground for planting hemp, *including fencing, burning, and subdividing in lots of* 1 mecate, is variable, according as the shape of the land is more or less regular, and according to its extent. The price which is at present being paid for these operations is:

Per linear mecate of fencing, 6 to 10 pesos according to quality.

For burning off the land, 5 cents per mecate.

For making small division marks, 10 cents per mecate.

The cost of keeping the land in good condition until the plants commence to produce varies according to the size of the shoots on planting, and the class of the land. The better the land, the larger the size of the shoot, and the sooner will it commence producing. As already mentioned (page 22) the time varies in Yucatan from five to twelve years. The cost of the work is, therefore, difficult to calculate. To cultivate hemp well it should have two weedings in the first three years, and one every eight months or year during the remainder of the life of the plant. The cost of this work fluctuates according to the condition of the plantations at the time the work is done, and varies from 40 cents to 1 peso 50 cents per mecate if the plantation has not been weeded for two or three years.

It is difficult to give the cost of cutting, bundling and loading on cars of one ton of hemp. The basis adopted in Yucatan for this work is per thousand leaves ; the weight of these varies according to their size, and the time at which they were cut, namely, whether during dry or rainy weather. The weight varies from 500 to 1,250 kilos. The price paid for cutting, removing the thorns, and transporting on men's backs to the road varies according to the size of the leaves from 60 cents to 1 peso per thousand.

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[1] 1 peso = 100 cents = 2s. (approx.).

For the transport of leaves from the plantation to the engine-house, payment varies according to the distance. When conveyed by platform cars, the cost is from 10 to 20 cents per thousand leaves ; but when by mules it is about 25 per cent. greater.

On all the farms payments are made in a lump sum per thousand leaves for the work of placing the leaves on the tables, cleaning, throwing away the refuse, carrying the fibre to the drying places, separating the clean from the stained, collecting the dry fibre, carrying it to the press house, including also the wages of engineer and fireman ; the payments made to all these workers and the number of men employed vary according to the machinery in use and the time occupied. The price of the work per thousand leaves fluctuates from 30 to 50 cents. To ascertain the cost per ton it would be necessary to know the average production of fibre per thousand leaves, which varies considerably in different regions of the State ; there are farms where the average is only 25 kilos., and others, unfortunately only a few, which produce from 30 to 34 kilos.

The baling is paid for according to the class of the press, whether worked by hand or steam power ; in the former case, the bale of 130 to 150 kilos. is paid for at from 50 to 75 cents, and in the latter case, the bale of 180 to 225 kilos. costs from 30 to 40 cents.

The cost of transport of the bales from the farm to the port of Progreso varies considerably, according to the distance of the farm from the railway, and the means of communication between the farm and the railway station, and the distance from Progreso. The present rate of freight per metric ton is 10·4 cents per kilometre ; an additional charge is made of 3·00 pesos per ton for loading and unloading.

In estimating the total expenses incurred in connection with henequen production, many other factors not mentioned above should be taken into consideration, such as:

The cost of the hemp shoots, their cutting, transport to plantation and planting.

The cost of the ropes used for making bales, and of those for tying up the leaves and hemp-shoots.

The annual replanting, which should be done on every farm during the first three years, to replace the dead plants and maintain the plantation in good producing order.

The cost of the firewood used in the boilers for the cleaning.

The proportional expense which should be charged for the farm labourers employed on the work and expenses incurred for the same during illness.

The constant repairs to the machinery.

The interest on capital invested in planting and production.

It should also be taken into account that the costs of production vary, according as to whether the farm has the necessary number of hands for its service or requires to employ men from outside, which is somewhat more expensive.

The actual expenses of the hemp in Progreso, not including freight, are at present 12 pesos per ton, but to this must be added 60 pesos per ton for export duty (plus 10 per cent. additional and 2 per cent. to the Municipality of Progreso) and 15 pesos (plus 50 per cent.) for entry into the port.

CEMENT MANUFACTURE AND ITS POSSIBILITIES IN THE CROWN COLONIES AND PROTECTORATES

PART III

In the first two parts of this article (this Bulletin, 1924, **22**, 173; 433), the possibilities of Cement Manufacture in the British Crown Colonies and Protectorates of Africa were considered. Part I also contained a description of the various kinds of cements used in building, and the methods employed in their manufacture. The present part deals with the British West Indies and other Colonies in the Western Hemisphere, and the island Colonies and Protectorates of the Pacific.

THE BRITISH WEST INDIES

Fairly large quantities of Portland cement are imported annually into the British West Indies, but, so far, no factory for its production has been established on any of the islands. Several projects have, however, received attention during the past few years, both from Government and private enterprise (see Jamaica, p. 34, and Trinidad, p. 38).

The trade in cement of the various Islands in the group during recent years is shown in the following table :

Imports

(Barrels of 400 lb.)

	1919.	1920.	1921.	1922.	1923.
Jamaica	25,593	62,512	26,215	52,478	92,440
Trinidad and Tobago	38,264	75,853	62,313	57,553	64,276
Leeward Islands :					
Antigua	646	—	1,253	3,543	4,257
St. Kitts and Nevis	1,122	—	3,890	3,685	4,146
Montserrat	7	—	620	205	101
Dominica	654	—	1,327	1,244	679
Virgin Islands	65	—	39	234	151
Barbados	8,596	18,071	9,733	8,762	12,204
St. Lucia	1,148	1,943	722	874	—
St. Vincent	1,473	1,574	1,500	1,465	1,564
Grenada	1,709	6,810	1,602	1,338	920

Re-Exports

(Barrels of 400 lb.)

	1919.	1920.	1921.	1922.	1923.
Jamaica	86	952	431	665	354
Trinidad and Tobago	9,758	10,465	5,278	5,703	7,748
Leeward Islands	72	—	740	—	—
Barbados	2,371	4,706	2,243	199	—
St. Lucia	308	262	nil	nil	—
Grenada	25	80	80	nil	nil

Jamaica

Geologically, Jamaica consists essentially of an elevated limestone plateau surrounding interior mountain ranges. The edges of the plateau form coastal bluffs with low-lying areas next to the sea. The interior mountain ranges are made up of shales and conglomerates with occasional marine limestones of the Blue Mountain Series, but the chief interest from the cement-making [illegible] of view lies in the coastal deposits near the [illegible] ticularly those in the neighbourhood of Kingston.

A proposal for cement-making was put forward in 1903, but after consideration it was dropped, as the deposits of limestone and clay which it was proposed to u[illegible] were situated 25 miles apart. Later, however, a more thorough examination was made by a London firm on behalf of the Island Government, from whose report the following statement has been principally compiled.

The pre-war consumption of Portland cement was approximately 11,000 tons per annum, but it may be assumed that at least double this quantity would be consumed, provided that cement of first-class quality suitable for use in irrigation schemes, canals, new buildings and harbour developments could be manufactured at a reasonable cost. In addition to these demands for internal *use, there is the possibility of creating an increased export trade with the other islands of the* West Indies, British Honduras and the Spanish Main.

In view of the above, it appears that a plant capable of producing 30,000 tons per annum which could be worked economically at a lower output, say 25,000 tons, would be the most suitable for the Island. It is essential that the works should be situated near a suitable port, and, on this account, it was considered advisable to confine investigations of raw materials to the neighbourhood of St. Catherine's and Rockfort.

To the west of Kingston, a large deposit of suitable limestone occurs at Port Henderson at the entrance to Kingston Harbour. The large alluvial Plain of St. Catherine, which stretches from the foot of Port Henderson Hill, contains argillaceous materials of various compositions. Port Henderson Hill consists almost entirely of hard white limestone, but contains pockets of soft white and brown marl.

At Port Morant, some 35 miles east of Kingston, there is an excellent natural deep water harbour and several excellent works' sites are available there, but there is no large uniform deposit of the necessary raw materials near enough to warrant extensive investigations.

The limestones occurring in the Port Henderson and Rockfort neighbourhood are uniform in character and their composition is represented by the following analyses:

		Port Henderson Hill. *Per cent.*	Rockfort Quarry. *Per cent.*
Lime	CaO	54·98	55·58
Magnesia	MgO	0·43	0·32
Alumina	Al_2O_3	0·12	trace
Ferric oxide	Fe_2O_3	0·18	trace
Manganous oxide	MnO	0·05	nil
Phosphoric anhydride	P_2O_5	0·03	0·02
Sulphur	S	0·06	0·04
Silica	SiO_2	0·10	0·06
Loss on ignition		43·89	43·94
Moisture		0·10	0·11

Limestones of the above composition are well adapted for use in cement-making.

An excellent site for a works would be at the foot of the large limestone quarries at Rockfort on the Kingston Harbour front about 4 miles east of Kingston, where there are excellent deep water loading facilities. No large deposit of clay or shale is easily accessible, but suitable argillaceous material could be readily brought by water.

It appeared probable that the requisite argillaceous material could be found at Byles Pen, about 6 miles from Port Henderson, where a clay deposit was found averaging at least 12 feet in thickness. This deposit has been extensively tested by sinking 30 trial pits varying in depth from 9 to 16 feet; in no case was the bottom of the clay reached and in only two cases were strata of sandy material discovered. Analyses showed that the whole deposit is very uniform in composition and it is quite suitable for admixture with Port Henderson limestone for the manufacture of Portland cement. By working the deposit to a depth of 12 feet, the yield of clay per acre would be about 28,000 tons, or each acre would yield sufficient for 3 years' supply at the rate of production of cement of 25,000 tons per annum.

The land is covered with bush consisting principally of cashew, lignum-vitæ and logwood, the value of which should pay for the cost of clearance. The uniformity and depth of the clay deposit at Byles Pen were found to be so satisfactory that it was recommended that an option be acquired on a portion of Byles Pen, approximately 25 acres in extent, and yielding clay of the following average composition :

		Per cent.
Silica	SiO_2	53·56
Alumina	Al_2O_3	21·19
Ferric oxide	Fe_2O_3	8·34
Lime	CaO	3·26
Magnesia	MgO	1·93
Sulphuric anhydride	SO_3	0·66
Carbon dioxide and combined water	CO_2 H_2O	9·02
Alkalis, etc. (by difference)		2·04

By using a mixture of one part of this clay with 3·1 parts of Port Henderson limestone (see p. 35), a Portland cement having the following composition could be manufactured :

		Per cent.
Silica	SiO_2	20·34
Alumina	Al_2O_3	7·55
Ferric oxide	Fe_2O_3	3·71
Lime	CaO	63·41
Magnesia	MgO	2·07
Alkalis, etc.		2·92

A cement of this composition would be of excellent quality and would comply with the requirements of the British Standard Specification for Portland Cement.

As the Byles Pen clay deposit is about 6 miles from the proposed site of the works, other nearer deposits were also sampled. Trial holes were put down on swampy ground on the north side of the road between Naggo Head and Port Henderson. Samples were only taken from 3 holes as the material from the others was very sandy. The analyses of these three samples (after drying at 100° C.) gave the following results :

		A	B	H
		5 ft. 6 in. deep, water at 4 ft. 6 in. deep.	5 ft. 6 in. deep, water at 5 ft. deep.	4 ft. deep. water at 2 ft. deep.
		Per cent.	Per cent.	Per cent
Silica	SiO_2	58·68	51·91	57·78
Alumina	Al_2O_3	19·15	19·82	18·96
Ferric oxide	Fe_2O_3	5·43	7·14	5·30
Lime	CaO	5·82	6·88	4·70
Magnesia	MgO	1·52	2·00	2·30
Carbon dioxide and water	CO_2 H_2O	7·84	11·12	7·14
Alkalis, etc. (by difference)		1·56	1·13	3·82

These results show that the deposit varies considerably in composition, and although the material could be used in conjunction with the Port Henderson limestone, it would not be advisable to rely upon it as the source of supply.

Trial holes were also put down between Naggo Head and Trenham Park, and the chemical analyses of the samples taken were as follows :

		C	D	E
		5 ft. 6 in. deep, water at 2 ft. deep.	4 ft. 6 in. deep, water at 2 ft. deep.	5ft. deep, water at 4 ft. 6 in. deep.
		Per cent.	*Per cent.*	*Per cent.*
Silica	SiO_2	49·30	50·60	52·02
Alumina	Al_2O_3	19·85	19·60	19·16
Ferric oxide	Fe_2O_3	5·43	6·70	6·44
Lime	CaO	8·94	7·90	6·44
Magnesia	MgO	2·64	2·53	2·55
Carbon dioxide and water	CO_2 H_2O	11·60	10·78	11·04
Alkalis, etc. (by difference)		2·24	1·89	2·35

These results show the deposit to be fairly uniform and suitable for use in conjunction with the limestone, but the presence of water at 2 feet would make it rather difficult to work.

A sample was also taken of the argillaceous silt brought down by the Rio Cobra and deposited on the south side of Hunts Bay. The depth of the water is about 4 to 5 feet, and the material could be obtained by dredging.

Its composition was as follows :

		Per cent.
Silica	SiO_2	31·15
Alumina	Al_2O_3	13·53
Ferric oxide	Fe_2O_3	6·65
Lime	CaO	10·94
Magnesia	MgO	3·10
Sulphuric anhydride	SO_3	1·11
Carbon dioxide, organic matter, etc.		27·62

The quantity and uniformity of this sludge deposit can only be ascertained by extensive dredging and sampling, and it does not seem advisable to rely on this source of supply at present.

In addition to the above-mentioned raw materials, a small quantity of gypsum would be required to control the setting time of the cement. On the basis of a yearly output of 25,000 tons, this would amount to about 250 to 500 tons per annum.

There is a fairly large deposit of nearly pure gypsum near to the carbonaceous series on the Chalky River. The deposit is near a driving road and about one mile from the main road. This material could be quarried, transported and loaded into barges at Harbour Head at a cost not exceeding 10*s.* per ton.

Suitable coal, both for steam raising and cement burning, can be obtained from the United States of America and possibly from Nova Scotia. Fuel oil could be used both for power purposes and cement burning and if obtainable at reasonable cost would be most suitable for the proposed works, since there would be a large saving in handling as compared with coal.

There is a good supply of fresh water at Naggo Head, where the drainage water from the plantation goes to waste, and this could be delivered at Port Henderson by open conduit. The amount available at the driest period is about 200 cu. yds. or 34,000 gallons per hour.

This drainage water, which comes from the canal irrigation, contains 29 grains per gallon of total solids, and has a total hardness of 13·16, of which only 1·40 is permanent.

The cost of production per ton of cement, at works, on an output of 25,000 tons per annum, is estimated as follows:

	s.	*d.*
Quarrying limestone at 1*s.* 6*d.* per ton (22.8 cwts.)	1	8·5
Getting clay at 6*d.* per ton (7·6 cwts.)	0	2·3
Labour	5	4·7
Filling and loading at 1*s.* per ton	1	0·0
Coal at £2 per ton	20	0·0
Repairs and renewals	2	6·0
Stores	2	6·0
European expert staff	4	0·0
Contingencies, 10 per cent.	3	8·7
	41	0·2

So far the proposals for the establishment of a cement industry in the Island have not materialised.

Trinidad

In view of the demand for Portland cement in the island, the possibility of producing it locally was considered in 1903, and a joint report was issued by the Government Analyst and the Government Geologist in 1905. This report contains the analyses of the limestones A, D, E, and F, quoted below.

Early in 1906 samples of local raw materials were forwarded to the Imperial Institute for analysis and technical trial.

Compact limestones of two geological ages are available on the gulf of Paria: (1) Laventille limestone, which is quarried south of Laventille hill and also forms the greater part of Gasparee, Carrera, and the Five Islands, and (2) Pointe à Pierre limestone.

Chemical analyses of a number of samples from these localities gave the following results:

		Limestones					
		Laventille.			Carrera.		Pointe à Pierre.
		A	B†	C‡	D	E	F
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	55·10	55·24	56·05	54·32	53·72	52·96
Magnesia	MgO	trace	1·02	trace	1·00	1·20	1·60
Alumina Ferric oxide	Al_2O_3 Fe_2O_3	trace	0·64	*	0·80	1·52	0·80
Silica	SiO_2	1·20	1·54	0·79	0·76	0·85	2·72
Moisture	H_2O	nil	41·84	43·60	0·10	0·30	nil
Carbon dioxide	CO_2	*			*	*	*

* *Not determined.*

† *Analysis made at the Imperial Institute.*

‡ *Analysis made by the Acting Government Analyst, Trinidad, in 1919.*

The supply of the Laventille limestone was stated to be sufficient for ordinary requirements, and the deposit easy to work. The amount of the Pointe à Pierre Cretaceous limestone in sight is not large, but similar rock occurs at San Fernando, whence it could be readily shipped.

Ample supplies of clay are found in the Gulf of Paria, and samples from two extensive deposits have been examined. The calcareous marl exposed near San Fernando is stated to occur at numerous points on the Southern coast and also inland.

Analyses of samples from three points near the Cipero river (Nos. 1 to 3) are shown in the following table, together with the results obtained in 1919 by the Acting Government Analyst, on a sample of mud from the Laventille swamp (No. 4).:

		1*. Per cent.	2*. Per cent.	3†. Per cent.	4‡. Per cent.
Lime	CaO	20·40	7·64	23·03	2·45
Magnesia	MgO	0·80	0·55	—	1·00
Alumina	Al_2O_3	18·75	8·16	13·61	11·78
Ferric oxide	Fe_2O_3			3·34	16·49
Phosphoric anhydride	P_2O_5	—	—	—	5·45
Sulphuric anhydride	SO_3	—	—	—	5·73
Silica	SiO_2	29·00	60·82	32·46	57·10
Moisture	H_2O	11·00	13·86	28·28	
Carbon dioxide	CO_2	15·49	5·85		
Loss on ignition		4·46	2·94		

* *Recalculated from figures given in the Report mentioned on p.* 39.

† *Analysis made at the Imperial Institute.*

‡ *Analysis calculated on organic matter and water free basis.*

Technical trials made at the Imperial Institute with limestone "C" from Laventille and clay No. 3 showed that, if used in suitable proportions, these materials would give a Portland cement of good quality, conforming in all respects with the requirements of the British Standard Specification.

Analyses made in 1919 by the Acting Government Analyst on samples of limestone from the Eastern Point of Point Gourde, west side of Telephone Bay, Luncheon Bay and the Eastern Quarry, showed 1·0, 0·1, 0·05, and 8·0 per cent. of magnesia respectively.

No cement factory has yet been erected in Trinidad.

Leeward Islands

The Leeward Islands, which comprise Antigua, St. Kitts, Nevis, Montserrat, Dominica, and the Virgin Islands, consume together about 7,000 barrels of Portland cement annually. This amount, however, would be insufficient to justify the erection of a modern plant with rotary kilns.

Antigua has deposits of a dark compact limestone at a few points in the valley in the south-west portion of the island, resting on the igneous rocks which comprise the mountain zone. The central plains are comprised partly of Tertiary strata, known as the Oceanic Series, which contain stratified tuffs and shales, with lenticular masses of cherty limestone. These beds are here overlain by the White Limestone Series. In the north-eastern part of the island a considerable depth of earthy marls and compact limestones occur and this would appear to be the most promising locality to prospect for cement materials.

St. Kitts has a basement of igneous rocks covered by the products of more recent volcanic activity. At Brimstone Hill a small volcanic dome and beds of white marl or limestone occur, dipping outwards from the centre of the dome. A small quantity of the limestone is burnt locally and is stated to be of excellent quality.

Dominica consists of volcanic ridges with deep gorges and is made up of Pleistocene and recent deposits and volcanic rocks resting on older igneous rocks. It is possible that a cement material could be made from the white marls found to a depth of 30 ft. in some valleys.

Barbados

Barbados has about six-sevenths of its surface covered with coral limestones which rest on the Oceanic Series, and these in turn on the Scotland beds. The last named consist of grits, sands, and mottled clays, the latter in some places containing asphalt and petroleum, all the beds being much foliated and faulted. The Oceanic Series, which rest on the eroded and upturned edges of the Scotland beds, consist chiefly of calcareous and siliceous white earths exposed to a depth of 250 to 300 ft. in the south-west coastal part of the island. Some parts of the deposit consist of earthy limestones of varying degrees of hardness. It seems possible that certain of these, notably those occurring at Melvins Hill and Mount Hillary, might yield hydraulic lime or natural cement if burnt at suitable temperatures.

The coral limestones usually rest unconformably on the Oceanic Series, but occasionally on the Scotland beds. The coral limestones are covered in some places by a deposit of red clay and loam.

It is evident, therefore, that there is every likelihood of there being in Barbados sufficient supplies of limestone and clay suitable for cement-making.

Bahamas

The Bahamas comprise two groups of islands composed almost entirely of coral sands of æolian origin which vary considerably in their degree of hardness and compactness.

In 1910 a sample of fairly pure white limestone was received at the Imperial Institute from Andros Island, Bahamas, and in 1911 a sample of "marl" was received from the Curator of the Department of Agriculture at Nassau in order that its suitability for cement manufacture might be ascertained.

An analysis made at the Imperial Institute gave the following results:

	Per cent.
Lime	52·48
Magnesia	0·89
Ferric oxide Alumina	0·10
Silica	0·09
Loss on ignition	45·17
Sodium chloride	1·18
Calcium sulphate	0·49

It was stated that large quantities of the material were available and the above analysis shows that it is quite suitable for use in making Portland cement provided a suitable clay is available in sufficient quantity.

A considerable quantity of lime is burnt for local use.

BRITISH GUIANA

The quantities of Portland cement imported into British Guiana during recent years have been as follows:

(Barrels of 400 lb.)

1919.	1921.	1922.	1923
47,431	48,136	33,797	19,159

So far as can be ascertained, no deposit of limestone of the size and quality necessary for cement-making has yet been located in this Colony.

In view of the extensive deposits of bauxite and the enormous reserves of water power available, the Colony would be very favourably situated for the production of fused cement of the type of "ciment fondu," provided that supplies of suitable limestone could be obtained at a reasonable cost.

BRITISH HONDURAS

Large deposits of limestone of Cretaceous and Tertiary age occur in several localities along the southern rivers, but the possibility of using these for making cement or hydraulic lime does not seem to have received much attention.

The lower hills of the Manatee ranges are composed chiefly of limestone, and a quarry opened up for obtaining ballast for the Stann Creek railway is stated to have yielded stone of good quality. Numerous deposits of clay also occur and wood fuel is abundant. It is possible that in the absence of fuel more suitable for cement-making, wood could be used in a manner similar to that employed in the Sudan (see this BULLETIN, 1924, **22**, 434).

A number of minerals, forwarded to the Imperial Institute in 1916, by the Colonial Secretary at Belize, were stated to have been collected by the Government Surveyor, in the neighbourhood of the Columbia branch of the Rio Grande river, in the Toledo District of British Honduras. Those of interest from the cement-making point of view were as follows :

Five samples, A, A1, A2, B, and C, all consisted of impure limestones. Sample D was a light-coloured medium-grained limestone, of promising quality and much less impure than samples A to C. E was a medium-grained limestone, closely resembling sample D, whilst F was a very impure limestone and G consisted of a compact white limestone. L was a specimen of limestone conglomerate ; and K was an impure clay containing sandy and vegetable matter, together with a certain amount of iron and manganese oxides.

It was stated that the limestones occur interstratified with shales and that the strata dip north-east and south-west.

The samples of limestone B, D, E, and G, were analysed at the Imperial Institute with the following results :

		B.	D.	E.	G.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	23·77	51·75	47·64	55·06
Magnesia	MgO	1·06	0·67	0·60	0·32
Ferric oxide	Fe_2O_3	2·78	0·65	0·98	0·19
Alumina	Al_2O_3	11·27	1·27	2·66	0·20
Silica	SiO_2	38·79	4·42	10·01	1·04
Loss on ignition		21·35	41·35	38·08	43·60

Sample B, which was analysed as being representative of specimens A, A1, A2, B, and C, contained too large a percentage of silica to permit of its emp[illegible] in the manufacture of Portland cement, and it [illegible] yield a building lime of only poor quality. If bur[illegible] suitable temperature it would probably give a fairly good hydraulic lime, but this could only be ascertained by practical trials.

Samples D, E, and G were limestones which could be used for the manufacture of Portland cement if incorporated with a suitable clay, shale or mud, and would also yield lime of medium quality for mortar-making. If burnt at a suitable temperature sample E would probably give a hydraulic lime of fair quality, but to ascertain this it would be necessary to carry out technical trials.

BERMUDA

The Bermudas contain numerous deposits of calcareous materials. The oldest formation seen consists of a hard, homogeneous, and crystalline æolian limestone, some beds of which are separated by thin deposits of red earth. Well developed exposures of the limestones are seen at *Harrington Sound* and Castle Harbour.

It is understood that in 1917 an American syndicate was investigating the possibilities of establishing a cement industry on the outskirts of Hamilton.

The quantity of cement imported into Bermuda totalled 15,794 barrels in 1922, and 25,485 in 1923.

ISLANDS OF THE PACIFIC OCEAN

The more important of these include the Fiji Islands, Solomon Islands, Gilbert and Ellice Islands, and the Tonga or Friendly Islands.

In view of the relatively small consumption of cement in the islands and their proximity to New Zealand, where Portland cement is already produced in quantity from local materials, it is unlikely that a cement industry could be successfully established on any of them.

Information regarding the occurrence of suitable materials is not available for islands other than Fiji.

The trade in cement in Fiji is shown in the following table :

	Imports. Tons.	Re-exports. Tons.
1919	1,521	nil
1920	2,345	115
1921	2,330	39
1922	1,115	57
1923	2,067	109

The quantity imported from 1911 to 1916 averaged 3,100 tons per annum.

The cement re-exported goes principally to Tonga, Samoa, Fortuna, and Wallis Islands, which seem to obtain all their supplies through Fiji.

Fiji Islands

These are composed largely of volcanic rocks, but some of the islands contain deposits of coral or foraminiferal limestone.

The question of the possibility of making cement in Fiji from local materials was referred some few years ago to the Imperial Institute, and the following details are taken from the report submitted to the authorities.

The cement making materials from Fiji examined at the Imperial Institute include: (1) "soapstone," from surface, Government Office Yard; (2) "soapstone," 6 ft. below surface, Suva; (3) porous limestone from Bacon Island; (4) white limestone from Aiwa; and (5) limestone ("marble") from Singatoka. The results of the analyses are shown in the following table:

		1. Per cent.	2. Per cent.	3. Per cent.	4. Per cent.	5. Per cent.
Ferric oxide	Fe_2O_3	5·40	7·54	*	0·30	0·17
Alumina	Al_2O_3	12·08	16·49	*	0·15	
Lime	CaO	19·24	12·77	49·56	55·02	54·10
Magnesia	MgO	6·95	5·78	*	0·81	1·41
Potash	K_2O	1·23	1·64	*	0·05	*
Soda	Na_2O	1·23	2·72	*	0·19	*
Phosphoric acid	P_2O_5	trace	trace	2·03	0·22	*
Silica	SiO_2	30·41	38·56	4·59	0·21	0·57
Loss on ignition		23·28	14·32	40·28	43·90	43·63

* *Not determined.*

These analyses were made on comparatively small specimens and it is possible that they may not represent the material which would be obtained if the deposits were worked on a large scale. The results, however, afford sufficient indication of the nature of the materials for the purpose of preliminary consideration.

From the information supplied to the Imperial Institute, it would appear that abundant supplies of both the " soapstone " and the Singatoka limestone (No. 5) are available. The latter forms a ridge two miles long, 400 yds. wide, and 200 to 500 ft. high. This deposit occurs usually less than half a mile from the Singatoka river, down which the stone could be carried by barge to Singatoka, 27 miles distant. The "soapstone" would not produce a Portland cement if burnt alone, and it would be necessary to incorporate it with a certain proportion of limestone. Of the limestones referred to above, No. 3 contains too large a percentage of phosphoric acid, but either No. 4 or No. 5 would be suitable.

If raw materials represented by the above analyses of " soapstone " (No. 2), and the Singatoka limestone (No. 5) were selected for cement manufacture, two methods of procedure would be available: (A) mixing 100 parts of the " soapstone " with 175 parts of the limestone, and (B) mixing 100 parts of the " soapstone " with 282 parts of the limestone and 22·5 parts of quartz sand. These mixtures, when burnt at a suitable temperature, should give cements having approximately the following composition:

		Mixture A. *Per cent.*	Mixture B. *Per cent.*
Silica	SiO_2	22·00	23·65
Alumina	Al_2O_3	9·32	6·50
Ferric oxide	Fe_2O_3	4·18	2·91
Lime	CaO	59·90	63·21
Magnesia	MgO	4·60	3·73

It will be observed that the quantity of magnesia in the cement in each case exceeds the maximum of 3 per cent. permitted by the British Standard Specification. It is evident, therefore, that if the analyses quoted above represent the approximate composition of the " soapstone " available for cement manufacture, it will not be possible with this material to produce a cement conforming in all respects to the requirements of the British Standard Specification.

The cement represented by mixture A would probably have a tensile strength rather under that of

Portland cement of good quality. Mixture B might be somewhat difficult to burn in a shaft kiln, but if burnt satisfactorily the product should approximate to a good cement. The requisite fuel would have to be imported.

If it were decided to consider the above-mentioned raw materials for cement manufacture, the deposits would have to be carefully examined in order to ascertain whether there is an adequate supply of material for several years' working and also the possible variations in composition from point to point.

NOTES

Imperial Institute Monographs on Mineral Resources.—Two new volumes in this series of monographs, dealing with bismuth ores and antimony ores, have recently been published by Mr. John Murray.

Bismuth Ores, by Robert Allen, M.A. (Cantab.), B.Sc. (Lond.), M.Inst.M.M., of the Scientific and Technical Department, Imperial Institute, is a book of 62 pages, and is published at 3*s.* 6*d.* It is divided into three chapters, the first of which deals with bismuth minerals and ore deposits ; mining, concentration, and metallurgy of ores ; and the properties, uses, value, and production of bismuth. In the second chapter are described the bismuth ore deposits of the British Empire, including those of Queensland, New South Wales, Tasmania, Burma, Rhodesia, South Africa, and Canada. The third chapter treats of foreign sources of supply, including those in Bolivia, China, the United States, Spain, Germany, Argentina, Peru, Yugo-Slavia, Austria, France, Japan, and Scandinavia.

The position of occurrences of bismuth ore are shown on a map, and the monograph concludes with a list of publications.

Antimony Ores, by Edward Halse, A.R.S.M., M.Inst. M.M., also of the Scientific and Technical Department of the Imperial Institute, contains 102 pages, and is published at 5*s.*

The first of its three chapters describes antimony minerals and their associations, and discusses the genesis and classification of the ore deposits ; it also deals with the mining and marketing of the ores and their metallurgical treatment ; and the properties, uses, prices, and production of antimony. Deposits of ore in British territory, including those in Australia, South Africa, Canada, India, and British Borneo, are enumerated and described in the second chapter, whilst the third chapter gives an account of foreign deposits, including those in China, Algeria, Yugo-Slavia, Mexico, Asia Minor, Czecho-Slovakia, Bolivia, Portugal, the United States, and Peru.

The book contains a map, showing the world's antimony deposits, and concludes with a bibliography of recent literature.

Platinum and Gold in the Transvaal.—In this BULLETIN (1924, **22**, 67) a note was published summarising the information then available on the recent discovery of platinum in South Africa. The note concluded with the remark that this discovery was expected to prove of enormous value not only to South Africa, but to the whole Empire, a statement which has been regarded in some quarters as unduly optimistic.

Since the preparation of that note a considerable amount of prospecting and development work has been done on the lodes, which it will be remembered are situated in the Waterberg District of the Transvaal. Whilst some very rich ore has been obtained in places, values continue to vary very rapidly and it seems that payable ore is only met with within a restricted area. Prospectors have been much hampered by the lack of any visible indicator-mineral, and for the same reason it is probable that those companies which are conducting actual mining operations have included with platinum-bearing ore some which may be barren. According to statements made by the Chairman of Transvaal Platinum, Ltd., the principal concern operating on the lodes, the Company has developed 4,500 tons of ore underground, which is believed to average over 100 dwts. per ton. The metal present is said to contain varying amounts of palladium, ranging from 5 to 50 per cent., the rest being platinum. The Rand Mines Research Laboratory are said to have obtained encouraging results with their extraction experiments, and a test plant is in course of construction.

Meanwhile an apparently important discovery has been made of alluvial platinum and of platinum disseminated through basic igneous rocks. According to a report by Dr. H. Merensky to the directors of Lydenburg Platinum, Ltd., published in the *South African Mining and Engineering Journal* (January 10, 1925, **35**, p. 474), the discovery was originally made in June 1924, in the bed of a stream on the farm Maandagshoek in the Steelpoort valley, Lydenburg district, just to the east of the Lulu Mountains, and others have since been made on neighbouring farms and in the extensive alluvial flats on the Steelpoort River at Burgersfort.

The area is composed of basic rocks of the Bushveld plutonic complex, chiefly norites, pyroxenites, and gabbros, with segregations of magnetite and chromite. In many parts of these primary rocks payable quantities of platinum have been recorded, the highest so far being 7·5 dwts. per ton on the farm Driekop, whilst over extensive stretches assay values of 2½ to 3 dwts. have been obtained. Dr. Merensky estimates the " pay limit " at the present price of platinum to be 1½ dwts. per ton, or if the price dropped to £15 per oz. of platinum, 2 dwts. per ton. These figures apply to igneous rock ; the alluvial material could be much more cheaply recovered, but the deposits are of comparatively small extent.

Dr. Wagner, of the Geological Survey, has now made a detailed investigation of the Lydenburg deposits, and his report, which has just appeared, will be summarised in the next issue of this BULLETIN.

In the same note in the BULLETIN (1924, **22**, 69), reference was made to the gold mines of South Africa which were stated to be " rapidly approaching exhaustion." As it has been suggested that this remark may be misleading, it may be stated that there was no intention of implying that the output of gold is in immediate danger but merely that (as indicated in the *Annual Report of the Transvaal Chamber of Mines for* 1922) many of the chief mines at present in operation are becoming worked out. This fact has been well expressed by Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa, who, in a " Report on the Economic Conditions in South Africa (July 1924) " issued by the Department of Overseas Trade, describes the gold industry as a " wasting " rather than a " waning " industry. He mentions that although during the past decade nineteen out of forty-nine producing mines have suspended operations, six new companies have entered the field, and their mines are among the largest and richest now being worked. Mr. Wickham also points out that there is no certainty that other mines or even other reefs will not be discovered, and that meanwhile the working costs have been so greatly reduced by scientific inventions and economies that rock once regarded as valueless has come into the profitable ore reserves and certain mines considered to be worked out have again become producers.

Cement Testing: New Machine for Compacting Cement-Sand Briquettes.—In *Engineering* (February 27, 1925) is described a machine for compacting cement-sand briquettes for testing. This machine was designed by Mr. A. T. Faircloth, of the Imperial Institute Cement Testing Laboratory, and was made under his supervision at the Institute. It was constructed for use in connection with the testing and certifying of British-made Portland cement intended for export to the Argentine.

The Argentine Government's specification requires that the cement-sand briquettes used for determining tensile strength shall be compacted six at a time by means of an apparatus in which hammers, each weighing 2 kilograms, fall 120 times from a height of 40 cms. The Imperial Institute machine is designed on the principle of a pile-driver; it has an automatic device for raising and releasing the hammers the requisite number of times, and fulfils the requirements of the specification in all respects. It effects a considerable saving in time and labour as compared with hammers of the Boehme type, and has been used in the Institute's cement laboratory for several years with very satisfactory results.

The paper contains a full description of the machine, illustrated by diagrams and a photograph.

Forestry in North Borneo.—An account of the work carried out during 1923 in connection with the forest products of North Borneo has been given in the *Ann. Rep. of the Forest Dept. of the State of North Borneo for* 1923.

During the year the amount of timber cut was 2,864,102 cub. ft., of which 2,134,341 cub. ft. were exported. These exports were distributed to the different countries in the following percentages: Hong Kong, 78·81; Australia, 1·91; British Isles, 5·54; Japan, 9·63; Shanghai, 1·58; Sarawak, 1·48; other countries, 1·05.

It has been proposed that a paper-pulp mill should be established in the vicinity of Beaufort, and at the request of the British Borneo Timber Company the area of Penotal Gorge has been examined by the Forestry Department, who have found that the timber suitable for pulping will average 621 cub. ft. per acre. There is also a large quantity of suitable timber available along the Padas River above its junction with the Pegalan near Tenom. The need for careful investigation before starting a pulp-mill is emphasised.

Consideration is being given to the production of alcohol from nipa palm sap for use as motor fuel (see this BULLETIN, 1922, 20, 315). At Kuala Semawang, Labuk Bay, 125 acres have been cleared for producing sap, a wharf has been constructed, buildings have been erected, and boilers and stills installed suitable for the production of 100 gals. of motor fuel per day. It is hoped that this experimental plant will eventually lead to the establishment of plants of greater capacity.

During October, a quantity of Kawang (Illipé) fat was extracted at a local coconut oil mill for submission to buyers in Europe. It is thought that it may be more profitable to extract the fat in Borneo than to export the nuts, and if the experiment is successful a small industry will be started in this direction.

Agriculture in the Netherland East Indies.—The present position of the agricultural industry of the Dutch possessions in the East Indies is dealt with in a *Report on the Economic Situation of the Netherland East Indies to July* 1924, by H. A. M. Bluett, British Commercial Agent, Batavia, recently issued by the Department of Overseas Trade.

It is pointed out that great care is being taken to maintain a high standard of agricultural produce by both growers and exporters, and no little credit for the prosperous state of the export trade is due to the Department of Agriculture at Buitenzorg and to privately supported societies that are collaborating in agricultural research with the object of increasing the output per acre of estates and of improving the quality of sugar, rubber, tea, coffee, palm oil, and other exportable products. The people are to-day reaping the advantage of an all-round improvement in production occasioned by the careful study of the scientific side of tropical agriculture, to which, as is well known, so much attention has been paid in the Netherland East Indies. There seems to be very little fear of over-production, as new connections made every year with produce brokers and merchants in consuming countries ensure the absorption of the steadily increasing output of the plantations.

The sugar industry is, in all respects, in a flourishing condition. The area under sugar-cane cultivation in 1923 was 401,490 acres, the total production of sugar being 1,765,000 metric tons. It is estimated that in 1924 the planted area increased to 425,444 acres and the production to 1,842,000 metric tons. The shipment of white cane sugar in 1923 amounted to 1,787,482 metric tons, against 1,369,617 tons in 1922 and 1,635,653 tons in 1921. The principal shipments were 264,772 tons to Hong Kong, 191,000 tons to Egypt, 187,000 tons to Calcutta, and 161,761 tons to Great Britain. In addition, 37,168 metric tons of brown muscovado and 111,151 tons of molasses were exported, as well as 5,368 tons of palm sugar.

The rubber industry is increasing by leaps and bounds and the Netherland East Indies now produce about one-third of the world's requirements. In 1923 the total exports of rubber amounted to 139,746 metric tons, of which 37·9 per cent. was native-grown. At the end of 1922 the rubber estates in Java and the Outer Islands had a total area of 7,684,000 acres, of which 7,512,000 acres were planted with rubber alone and the remainder with rubber and intermediate crops. Between 90 and 100 million rubber trees are owned by the native population, of which it is doubtful whether 20 per cent. have yet been tapped. In common with the practice adopted in Malaya and Ceylon, British-owned companies in the Netherland East Indies have restricted output with a view to avoiding over-production and to maintaining prices at a level which permits of a small profit being earned. Their voluntary sacrifices, expressed in terms of the volume of rubber withheld from the market, have been nullified, however, by the increased production and export of the rubber grown by natives. During the past seven years rubber planting by natives has spread to all parts of the Dutch East Indian Archipelago, and is proving a most remunerative occupation ; it is bringing wealth to the population, and in the Djambi and Palembang residency of Sumatra and in South-east and West Borneo the industry is of national importance.

In the course of an extended tour of Sumatra, covering over 2,000 miles, Mr. Bluett made an exhaustive study of the native rubber question. Nowhere in the vast area examined did he find any sign of over-tapping or disease ; the native gardens are well cared for, the trees well planted out and tapped according to the usual estate practice. The quality of the rubber produced is improving ; almost every homestead is now provided with hand rollers, while great care is being maintained in manufacture, which, though still crude, is based on the practice adopted by estates. There appears no reason why native planting should not continue to increase in Sumatra and Borneo ; the land available is still practically unlimited and the natives have a free and uncontrolled right of occupation of new ground. The general opinion expressed in the country is that rubber production will follow on the lines of the copra industry and yearly become more and more a native culture. How far estates will be able to compete with the native growers remains a problem for the future.

The chief variety of coffee grown in the Netherland East Indies is Robusta. Out of a total production of 57,350 metric tons in 1923, Robusta represented 82·1 per cent., Java 15·5 per cent., Liberia 1·1 per cent., and other kinds 1·3 per cent. The estimated production in 1924 shows an increase of about 10 per cent. in the output of Robusta coffee and a decrease in the quantity of Liberia and Java kinds. The exports of Robusta coffee from Java totalled 18,624 metric tons in 1923, against 38,326 tons in 1922. The decrease is accounted for by the ravages of the coffee berry bug. In Sumatra, where the ravages of this pest are not so serious, many new estates are coming into bearing and the output of coffee is increasing; the exports from the Outer Districts, which include Sumatra, were 12,556 tons in 1923, as compared with 6,562 tons in 1922. Most of the Java-grown coffee goes to Singapore, the United States, Holland and France.

There is a small production of cocoa, the exports in 1923 amounting to 1,147 metric tons.

The tea trade of the Netherlands East Indies is in an extremely strong position; the demand is well maintained and prices remain at a high level. In round figures, the production in 1923 totalled 48,300 metric tons, an increase of 4,800 tons on the previous year. Of this total 40,800 tons was produced in Java and the remainder in Sumatra. The exports from Java amounted to 40,972 metric tons, the chief customers being Great Britain (12,247 tons), Holland (11,431 tons), Australia (11,009 tons), and the United States (3,885 tons). Sumatra exported 7,493 metric tons in 1923. The tea industry of Sumatra is of recent date, the first estate being opened by British capital in 1910, followed by Dutch interests in 1912. In many places in the highlands of the island there is land available well suited for the cultivation of tea, and further development in this direction appears assured.

The exports of leaf tobacco from Java and Madura for 1923 amounted to 13,371 metric tons, against 15,697 tons in 1922. Nearly all the shipments went to Holland, which also took most of the 24,229 metric tons of Krossok tobacco (shag) exported in 1923. The exports of Deli tobacco from Sumatra in that year amounted to 15,037 metric tons, a decrease of 123 tons as compared with the previous year. According to long-established custom amongst planters on the East Coast of Sumatra, the tobacco fields are planted only once in every seven years;

during the intervening six years the ground is rested and improved by planting teak. If grown on the same ground more frequently, the tobacco is of inferior quality and subject to disease. Experiments have been in progress, however, which seem to show that if *Mimosa* sp. is planted for three years after the tobacco crop has been harvested, the ground can be planted with tobacco in the fourth year, the quality of the leaf being not thereby lowered, while the plants are freer from disease than if grown in soil that has been under teak for six years. By adopting this practice the output of Deli leaf tobacco could be increased, or, alternatively, valuable land would be released for other crops.

The area devoted to the cultivation of the oil palm in Sumatra continues to increase. The total area planted up to the end of 1923 was 38,000 acres, or three times as much as it was five years ago. The area producing in that year was just over 10,000 acres. The quantity of palm oil produced during the past five years was as follows: 1919, 576 metric tons; 1920, 1,719 tons; 1921, 2,471 tons; 1922, 3,645 tons; and 1923, 3,947 tons. The production during 1924 is expected to show a heavy increase, while in future the output is expected to increase annually by between 1,500 and 2,500 tons. The production of palm kernels in 1923 was 850 metric tons. The total output, although still small compared with the world's production (Nigeria alone in 1923 exported 223,000 long tons of kernels and over 99,000 tons of palm oil), is, as will be seen, steadily increasing, and much interest in the crop is being shown by both Dutch and foreign capitalists. At present oil palm estates are confined mainly to the east coast of Sumatra and Atjeh, but recently opened-up estates on the west coast of Sumatra show every promise of success.

The chief oil-seed produced for export is copra, which, as already indicated, is essentially a native crop; the exports from Java and Madura in 1923 were 53,060 metric tons, whilst 18,000 tons of copra cake and 1,400,000 litres of oil were also exported. There was also an export of 10,000 tons of copra from the East Coast of Sumatra. The local consumption of coconuts and coconut products, however, far exceeds the exports, at least in Java. Other oilseeds exported include kapok seed (21,500 tons), decorticated ground-nuts (7,900 tons), undecorticated groundnuts (5,800 tons), sesame (1,200 tons), and castor seed (1,000 tons).

Considerable quantities of sisal hemp are grown, the exports in 1923 amounting to 14,300 metric tons. No less than 12,700 tons of kapok were shipped, and there is also a small export of cotton.

The export of cinchona bark in 1923 was 6,900 metric tons, and of quinine 553,000 lb.

In addition to the cultivation of agricultural produce by estates under European or Chinese management, principally for consumption in foreign markets, there is a vast area under cultivation in so-called native produce, for the primary purpose of feeding the 50 millions that inhabit the islands, and of which only the surplus production is shipped abroad. Preliminary figures show that, in 1923, 15,871,000 acres were under cultivation in the following foodstuffs and oil-seeds: irrigated rice 7,340,000 acres, dry rice 880,000 acres, maize 4,028,000 acres, cassava 1,836,000 acres, sweet potatoes 435,000 acres, groundnuts 460,000 acres, soya beans 410,000 acres, other leguminous crops 482,000 acres. There is also much ground planted with tropical fruits, such as bananas, mangoes, pineapples, etc. The chief food of the population is rice, and although 25,000 metric tons of cleaned rice were exported from Java and Madura in 1923, the imports from Siam, India and Indo-China amounted to 200,000 tons. It is considered unlikely that the Netherland East Indies will ever become self-supporting in rice, but great efforts are being made to extend the area under cultivation and increase the yield per acre, for which purpose irrigation works, costing several million guilders, are undertaken every year. Other important foodstuffs exported from Java and Madura in 1923 were maize (38,000 metric tons), tapioca flour (70,000 tons), pearl tapioca (12,100 tons), flake tapioca (5,600 tons), and cassava roots (22,700 tons), whilst 7,500 tons of sago were shipped from the East Coast of Sumatra.

Other agricultural products exported from Java and Madura in 1923 included black pepper 8,000 metric tons, white pepper 2,200 tons, betel nuts 7,800 tons, coca leaves 1,150 tons, nutmegs (ground and unground) 300 tons, and citronella oil 480 tons.

The Work of the United States Bureau of Plant Industry.—The activities of the United States Department of Agriculture are divided among a number of bureaux of which that concerned with Plant Industry is perhaps the most important. An account of the work of this Bureau is contained in the *Annual Report* of the Chief of the Bureau for the fiscal year ended June 30, 1924, from which the following notes are taken.

The activities of the Bureau of Plant Industry are concerned primarily with agricultural research and related experiments, although incidental services, regulatory functions, and extension work are also carried out. The scope of the research work includes the study of destructive plant diseases and the establishment of methods of eradication and control; the improvement of crop, ornamental, or other economic plants by breeding and selection; the introduction of promising seeds and plants from foreign countries; the improvement of methods of plant production, and the utilisation of plants of economic value.

The service activities are conducted in co-operation with the authorities of the different States. During the year under review these included a campaign for the eradication of the barberry in thirteen important wheat-growing States with the object of controlling black stem rust of wheat; the eradication of currants in New England, Great Lakes, and Pacific North-West areas to control the blister rust of white pine; and the eradication of citrus canker from the Gulf States.

The regulatory activities during the year were limited to the enforcement of the Seed-Importation Act, and the extension activities to the administration of the demonstration work on federal reclamation projects.

The appropriations available for the work of the Bureau for the year were approximately $3,485,000. This was apportioned to the several types of work as follows: research work $2,700,000; service work $735,000; extension work $40,000; regulatory work $10,000.

It is impossible in a brief note to deal adequately with the very large amount of work carried out by the Bureau (the list of publications issued during the year contains 370 entries), but the following items may be given to indicate the wide scope of the work. The production of new citrus hybrids, varietal tests of date palms, the development of better and earlier ripening summer apples, experimental cultivation of the pistachio nut, breeding of potatoes and study of their diseases, investigation of a method of growing flax and wheat as a mixed crop, introduction of varieties of barley and wheat from North Africa, India, and other countries, tests of about 3,000 sugar-cane seedlings and imported standard varieties, experiments with various leguminous crops and grasses, a study of improved cultural methods of cotton, breeding Egyptian cotton, development and improvement of the fibre industries of the Philippine Islands in co-operation with the Philippine Bureau of Agriculture; study of diseases of forest trees, investigation as to the possibility of utilising native plants as a source of rubber, effects of crop rotations on tobacco, and soil, manurial, and irrigation problems.

In addition to the work carried on at home the Bureau sent an expedition to the Amazon Valley to obtain data for comparing the conditions of production and methods of extraction applied to the wild rubber trees with those of the plantations in the East; Hevea leaf disease was studied in the Guianas and Trinidad; and, with a view to developing a source of supply of chaulmoogric acid in the Western Hemisphere, several thousand plants of two species yielding chaulmoogric acid were distributed to parts of tropical America. One of the two species was the West African shrub *Oncoba echinata*, the oil of which was first shown to contain chaulmoogric acid by investigations carried out by Goulding and Akers at the Imperial Institute (see this BULLETIN, 1913, **11**, 439). The other species was *Taraktogenos Kurzii*, the official source of chaulmoogra oil. Plants of *Hydnocarpus Wightiana*, another source of chaulmoogric acid, were sent to Balboa in the Panama Canal zone by the Department three years ago, and these are now bearing.

New Cotton Periodicals.—Two new periodicals devoted to the cotton-growing industry have appeared recently, viz., *The South African Cotton Growers' Journal* and *The Australian Cotton Grower, Farmer, and Dairyman.*

The former publication, which is issued monthly at Durban, is intended for the information of cotton growers in South and East Africa and is circulated in Natal, Zululand, Transvaal, Orange Free State, Cape Colony, Swaziland, Rhodesia, Nyasaland, Uganda, Portuguese East Africa, and Kenya Colony. It contains matter of a varied nature, including notes on the cotton markets and the cotton situation generally, and particularly with reference to the countries mentioned. The issue for February 1925 gives a brief sketch of the career of Mr. S. Milligan, M.A., B.Sc., who has been seconded for service to the Union Department of Agriculture by the Empire Cotton Growing Corporation. A photograph of Mr. Milligan is reproduced and it is stated that "working in co-operation with the Union Government, he has been materially instrumental in the inauguration of a systematic programme of cotton cultivation which will be of considerable benefit to the industry."

The *Australian Cotton Grower, Farmer, and Dairyman* is a monthly journal of a similar character, devoted to the interests of cotton-growing in the Commonwealth.

Previously there have been two periodicals dealing with the Australian cotton industry, viz., *The Australian Cotton Grower*, which was the organ of the British Australian Cotton Association, Ltd. (published at Sydney), and *The Cotton Farmer and Dairyman* (published at Rockhampton, Queensland), which was the organ of the Queensland Cotton Growers' Union. These two journals are now incorporated in the new publication. It is pointed out in the editorial foreword to No. 1 (January, 1925) that to many people it has appeared that the two earlier organs "represented opposing interests, inasmuch as the name of the British Australian Cotton Association has been associated, against its wish and against fact, with the restrictive legislation on cotton growing passed by the Queensland Legislature." This legislation, it is stated, was calculated to affect the interests of the Association in exactly the same degree as those of the farmers. The two bodies have the same object, namely, to develop the Australian cotton-growing industry, and it is hoped that by sinking all personal and political feelings and by unbiassed co-operation that object may be achieved.

The hope may be expressed that these two new journals will be welcomed by the cotton-growing communities in South Africa and Australia respectively, and that they may be of considerable service in assisting to build up extensive and stable industries in both Dominions.

Sale of Government Crown Estates in Western Samoa.—Tenders are invited by the New Zealand Government for the lease of a number of properties formerly owned by Germans on the island of Upolu in Western Samoa. The properties offered include plantations of coconuts, cocoa, pineapples, Para rubber, etc., and also a rest house and the Casino. Tenders will be accepted up to April 30, 1925, at the office of the Secretary for External Affairs, Wellington, and of the High Commissioner for New Zealand, London. An illustrated catalogue of the properties and full particulars may be obtained on application to Mr. S. J. Collins, c/o the High Commissioner for New Zealand, 415, The Strand, London, W.C.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Sugar Cane.—*Circular* No. 12, 1924, *Dept. Agric., Uganda*, consists of a review by the Sugar Adviser, Mark S. Moody Stuart, of the production and prospects of cane sugar in the Protectorate. The view is expressed that, owing to transport and climatic conditions, only a small portion of the country can be economically devoted to sugar cultivation. The most suitable districts are Entebbe and the lakeside portions of Mengo and Masaka in Buganda, and Bukedi and Busoga in the Eastern Province. Bukedi and Northern Busoga will be served by projected railway extensions, while the southern part of Busoga is accessible from the lake. Small patches of sugar are fairly common, and most of the cane produced on them goes into direct consumption in the green state. There are, however, occasional larger areas where Europeans or Indians have small "jaggery" plants, but on the whole the cane does not receive much attention, and tangled masses of it are to be seen that have not been touched for three or four years. Mr. Stuart considers from the appearance of the cane that soil and climatic conditions are admirably suited to its cultivation and that, with fair treatment, excellent crops might be expected. The average yield of cane throughout the country is between 30 and 35 tons per acre, but it is considered that 50 tons or more could be easily obtained with proper attention. The jaggery plants consist mainly of the 3-roller, vertical-type mills, worked by cattle or porters, and the boiling is done in open pans. The product varies from a light-coloured, soft-grained sugar to a sticky, unpalatable mass, but, on the whole, the production seems to be a paying enterprise, as the entire output meets with a ready sale in the neighbourhood where it is made. A modern plant is being installed at Lugazi, capable of turning out one ton per hour of white plantation sugar of good grade. ure development of sugar in Uganda may follo of two lines. The producer can either turn out a refining or direct consumption sugar for export or devote his attention to the potential local market, which should slowly develop to large dimensions. The latter course with the simpler plant is thought to be more likely of success, in view of the difficulties of internal transport. The *Circular* contains suggestions regarding cultivation and machinery, and the production of centrifuged muscovado sugar.

Sugar Beet.—The prospects of reviving the beet sugar industry in Western Canada are discussed in *Agric. and Indust. Progress in Canada* (1924, **6**, No. 11, p. 203). This industry, after a brief existence, came to an end in 1912, owing, it is stated, to lack of experience and to mismanagement. The irrigated blocks of Southern Alberta are regarded as having great possibilities, and experiments at Lethbridge, Gleichen, and other places in that area, have indicated a superiority both in tonnage and sugar content over beet production in the Western United States. In the spring of 1924, 152 farmers of the Raymond district grew beets on test plots of a total area of 3,119 acres. The promoting company declared the results entirely satisfactory and it is understood that a sugar plant will shortly be erected in a suitable locality. With regard to other areas, experiments extending over some years have established that sugar beet of excellent quality can be produced in Manitoba, the soil of the Red River Valley being well adapted to its production. It is thought that in the near future an American concern will establish a plant at Winnipeg.

Experiments by the Canadian Pacific Railway Co. have been continued and small tracts of sugar beet have been planted in various districts of the vast Irrigation Block it controls east of Calgary, Alberta, where the soil is stated to be suitable.

According to *Austr. Sugar J.* (1924, **16**, No. 6, p. 412), important developments are contemplated in connection with the Maffra (Victoria) beet sugar factory. The State Government has decided to enlarge the factory from a capacity of 350 tons of beets per day to 600 tons, engaging for the purpose an American engineer experienced in this work. The present crushing machinery allows for the treatment of the produce of only 2,000 acres a year, whereas the enlarged factory will be capable of handling the roots from 5,000 acres. It is stated that in 1924 a good profit was realised by the Victoria beet sugar industry.

Sugar Maple.—In the 1924 season, Canada produced 9,385,415 lb. of maple sugar, valued at $1,907,599, and 1,987,415 gallons of maple syrup, valued at $4,083,542. Quebec is commonly regarded as the almost exclusive producer of maple products in Canada, but the statistics of 1924, when the first attempt was made to record the industry throughout the Dominion, show the revenue secured from maple trees by other provinces to be far from insignificant (*Agric. and Indust. Progress in Canada*, 1924, **6**, 205). The figures of production are Quebec 8,876,525 lb. of sugar and 1,176,656 gallons of syrup ; Ontario 407,280 lb. of sugar and 773,826 gallons of syrup ; Nova Scotia 51,500 lb. of sugar and 9,565 gallons of syrup ; New Brunswick 50,110 lb. of sugar and 27,368 gallons of syrup. It is estimated that in the four Eastern provinces there are 60,000 farmers engaged in the industry, but that not one-half of the available sugar maples in this area are made productive. To stimulate the industry in Quebec, further development by the farmers is being encouraged, schools are being established and the industry protected. The export of maple products is increasing ; in 1922 2,092,715 lb. of sugar were exported, while in 1924 the quantity amounted to 2,784,070 lb.

Coffee.—An account of the occurrence of the insect pest, *Stephanoderes coffeæ*, Hagerdorn, in the coffee plantations in the State of Sao Paulo, Brazil, is given in the report of a commission, appointed by the Secretary of Agriculture of the State to investigate the menace, and is reprinted in *Tea and Coffee Trade Journ.* (1924, **47**, No. 5, p. 751). It is stated that the pest originated in Campinas, but when is not known, though it is certain that it has existed there for more than three years. The centre of the Campinas municipio is the most infested area, while two other municipios, Indayatuba and Mogymirim, are contaminated, and the presence of an insect pest is also reported from Jundiahy and Limeira. It is thus seen that according to the investigations made hitherto, only a small part of the coffee area of Sao Paulo is affected. The commission concludes that the extermination of the pest is almost impossible, but points out the importance of immediate and drastic measures to control its ravages, as otherwise a progressive diminution in the State's coffee crop will result, with the ultimate risk of total failure. A description of the pest is given and remedial measures are discussed. It is not considered advisable to destroy the trees, but precautions are recommended to avoid transporting the pest from infected areas to other districts. Under a decree signed by the President of Brazil on June 21, 1924, the municipalities can compel growers to repick the trees and free the ground from coffee beans, and to destroy affected trees ; they may also prohibit the transportation of trees, cuttings or branches bearing coffee, and may carry out any further measures which become necessary.

On p. 754 of the same journal is a short article on *Stephanoderes coffeæ*, which states that the original home of the insect is apparently the eastern part of Africa, and that the planters of Uganda have been acquainted with it for some time. It made its appearance in Java about three years ago, and by 1922 the pest had reached formidable proportions, threatening the coffee industry with extinction. The question of combating the pest is being investigated by the authorities in Java, and the production of a hybrid, more or less resistant to the ravages of the insect, is considered possible. A wasp was discovered in Uganda which parasitises *Stephanoderes*, and a batch of them has been taken to the Java Experiment Station for propagation. It is no doubt due to the existence of this parasite that *Stephanoderes* in Uganda has not been considered a serious pest.

Tea.—*Farmers' Journ.* (East Africa), (1924, **6**, No. 40, p. 5) contains a copy of the draft scheme proposed by Brooke, Bond & Co. for tea production in Kenya Colony. It has already been shown that certain areas in the Colony are eminently suited for the cultivation of tea, but apart from a company at work at Kericho and at Kakonde in Uganda there are no large tea estates in East Africa. Brooke, Bond & Co. have purchased land at Limuru for planting tea and for the erection of a factory. They propose to make agreements with neighbouring estate owners whereby they will supply the latter with tea seed and expert assistance and will receive the produce for fifteen years, and manufacture and dispose of the finished tea. The Limuru residents have considered the scheme and generally approved it, subject to certain amendments.

The United Planters' Association of Southern India have issued as a *Bulletin of the Scientific Department* a " Report on Mosquito Blight (Helopeltis) of Tea in Java " (1924), compiled by Herbert Ashplant, who, while visiting Java, investigated the combative measures employed there against this insect. The first part of the report describes the pest, its occurrence, and the ordinary remedial measures, the chief of which are spraying the bushes, immediately after pruning, with a 2 per cent. soap solution, and hand-catching. The second part of the report discusses a new method of control, which during the last few years has given successful results, and is known as the van Hooff system of alternate row pruning. Alternate rows (A rows) are pruned when the bushes have reached a height of about 54 in., being pruned to 24 in. from the ground. Side branches are left, the lower branches lightened and the centre cleared from irregular growth. Twelve months later the intervening rows (B rows) are similarly pruned. After an interval of two years the A rows are again pruned and the following year the B rows and so on, so that there is actually an interval of three years between the successive prunings of any one row. Only gardens which have been freed from the worst effects of blight by good husbandry are fit for the application of the van Hooff system. The explanation of the highly successful results obtained is not clear. The insect has weak powers of flight and the interposition of the tall, non-pruned row may act as a barrier, as it provides a smaller food supply and a less favourable site for propagation than the succulent growth on pruned bushes.

[Papers on this system by van Hooff, Bernard, Garretsen and others will be found in *Mededeelingen van het Proefstation voor Thee*, No. 81, 1922.]

With the *Indian Trade Journ.* (1924, **75**, No. 964), is issued a supplement, " Indian Tea Statistics, 1923." Of the total area of 710,300 acres under tea, 669,400 acres were reported to have been plucked as against 653,500 acres in the preceding year. Eighty-three per cent. of the area lies in Assam and in the two contiguous districts, Darjeeling and Jalpaiguri, of Northern Bengal, while the elevated region over the Malabar Coast represents thirteen per cent. of the total. The total production of green and black tea in 1923 amounted to 375,356,000 lb. as compared with 311,639,000 lb. in the previous year, an increase of 20 per cent. The amount of black tea produced was 371,086,400 lb. The average production of manufactured tea (green and black) per acre plucked varied from 36 lb. in Hazaribagh to 817 lb. in Madura, the general average for the country being 561 lb.

OILS AND OIL SEEDS

Castor Seed.—The cultivation of the castor oil plant is being undertaken in Morocco as a means of consolidating the sand dunes (*Bull. Econ. Indochine*, 1924, **27**, 417). Trials already made there have shown that *Ricinus sanguineus* is the most suitable variety and that its seeds yield 52 per cent. of oil. Five hundred hectares of sand dunes have already been planted with castor seed and the plants are growing well. It is expected that in a few years the crop will reach two or three hundred tons per year.

Coconuts.—According to a memorandum which has been published as a Sessional Paper, steps are being taken to draw up and put into operation a scheme for coconut research in Ceylon, on lines somewhat similar to those of the Ceylon Rubber Research Scheme (*Times of Ceylon*, October 28, 1924, p. 9). The necessity for investigations on coconut cultivation has been recognised by the Ceylon Agricultural Department ever since its inception in 1912. In 1914, 15 acres of Millicent Estate, Chilaw, were established as the Chilaw Coconut Trial Ground. Here experiments have been conducted to afford information on the value of various methods of cultivation, on the results of manuring and the effects of different manures on the yield of nuts and the output of copra. These experiments have proved of value in several directions, but it is found now that the area of this trial ground is too small for the additional experiments necessary to establish conclusive results. Moreover the soil at Chilaw is somewhat irregular and the growth of the palms on some parts is unsatisfactory.

As a result of action taken by the Estates Products Committee of the Board of Agriculture, the Low-country Products Association and the Planters' Association, the Governor of Ceylon in Executive Council has decided that the Government should support the scheme proposed by these bodies for the establishment of an Experimental Station in the principal coconut-growing area, the necessary funds for which should be provided by the Government and the coconut industry. The Legislative Council are to be invited to sanction a contribution on a fifty-fifty basis, up to a maximum of 90,000 rupees per annum, and to make a loan of 250,000 rupees at 5 or 6 per cent. for the purchase of the Experimental Station, the loan to be repaid in ten annual instalments. The industry propose that their contribution should be collected by an additional export tax of one-twentieth of the present duties, as follows: 15 cents per 1,000 nuts; 3¾ cents per cwt. of oil; 3 cents per cwt. of copra; 4·2 cents per cwt. of desiccated coconut. No further duty is contemplated on poonac or fibre. The additional tax is expected to bring in 90,000 rupees per annum. These proposals have been approved by the Secretary of State for the Colonies.

The contributions from industry and the grants from Revenue are to be vested in a fund, administered by an Executive Committee with the Director of Agriculture as Chairman. This Executive Committee will be composed of representatives of the industry, nominated by the Governor, and of representatives of the Government, including a financial officer, possibly the Assistant Colonial Treasurer.

An account of the year's work is to be submitted annually to a general public meeting by the Executive Committee and its technical officers, who will probably consist of an agriculturist, an entomologist, a mycologist, and a travelling officer. After payment of salaries, 120,000 rupees per annum will be available for experimental work out of the income of 180,000 rupees.

The Central Experimental Station should consist of not less than 100 acres of coconut palms in full bearing; 100 acres of young plants; and 200 acres for development work. When this Central Station has been fully equipped and opened, it is intended to start co-operative trials with coconut growers and to open subsidiary stations or trial plots in other important coconut-growing districts.

The methods used in the manufacture of copra in the Philippine Islands are described in a recent issue of the *Philippine Agricultural Review* (1924, **17**, 101). The cultivation of the coconut is one of the most important industries in these islands, but the Philippine copra fetches the lowest price in the world's markets on account of its poor quality, which is due to insufficient and faulty drying and handling.

Less than 0·5 per cent. of the copra produced in the Philippines is dried in modern driers, the bulk being tapahan dried (see below). Although efforts have been made from time to time to induce planters to improve their methods of preparation, on only a few plantations have good driers been installed. As small parcels of superior copra do not fetch increased prices, there is no hope of improving the price of Philippine copra unless the producers combine and produce copra of a superior quality in large quantities. The various methods of drying copra at present practised are described, of which the following are the more important.

In those parts of the Islands where the climate permits, sun-drying of the copra is used, but this method is impracticable in the chief producing districts, so that tapahans have to be employed. In this method, the kernels are spread out on grills made of bamboo, which are placed over an oblong pit. At one end of this pit a fire is lighted and the hot air and smoke produced dries the copra. Such copra, however, is often insufficiently and unevenly dried and becomes dark and discoloured from the smoke; it is therefore of inferior quality and fetches a low price. The nuts are usually husked by hand and then split, although in some districts the unhusked nuts are split open by an axe and the meat removed by a special knife. This latter method is considered more economical. At one plantation at Polo, a further saving is effected by carrying out the splitting operation in the field and transporting the meats only to the driers, the husks being ploughed under.

Experiments were carried out a few years ago by the Bureau of Science in which the meats were exposed to sulphur dioxide before being sun-dried, but although these trials were successful, this method does not appear to have been adopted except on one or two plantations (see this BULLETIN, 1923, **21**, 388).

In some districts where the conditions are favourable, the copra after sulphuring is air-dried in sheds. It is spread out on bamboo trays arranged in four tiers, 1 metre apart, the lowest tier being 1½ metres from the ground. The sides of the sheds are covered with palm leaf awnings to protect the meats from rain. Six to eight days are required for drying by this process.

In the Patalon drier, which is an adaptation of the tapahan drier, the meats are spread out on a grill built above an arch of stone or brick, enclosed by a brick wall. The arch serves as a furnace and radiates hot air which, rising through the grill, dries the copra. Such a drier has the advantages that it can be easily constructed from materials readily available; that it can be worked by any unskilled labour, and that, being constructed of brick, there is very little danger of fire.

In using the Patalon drier, the nuts are split and placed meat downwards on the grill over the sheet iron flues where the heat is greatest. After the meats have been loosened, the shells are removed and the meats placed above the furnace where the heat is less intense. This drier is considered to be especially suited to small planters, i.e. those with less than 200 hectares. The resulting copra, however, is often unevenly dried.

As considerable interest is being displayed in the

economic aspects of the cultivation of the dwarf coconut, known locally in Malaya as " nyior gading," information has been recently published in the *Malayan Agricultural Journal* (1924, **12**, 371) to show how this variety compares with the ordinary coconut palm as a commercial crop. The data, which have been compiled from several estates under good average conditions, show that " dwarf " palms, 6 to 10 years old, give approximately twice as many nuts as the ordinary palms ; that twice as many " dwarf " coconuts as ordinary ones are required to produce a given weight of copra ; that after ten years, the " dwarf " variety gives a yield of 19 cwts. of copra per acre in comparison with 10½ cwts. for ordinary coconut palms ; and that the " dwarf " palms are planted 90 to an acre, thereby giving 9,000 nuts per acre, while in the case of ordinary palms the figures are 48 and 2,500 respectively. The life of the " dwarf " variety is generally considered by the natives to be half that of the ordinary palm, but it is thought that with good estate cultivation the former ought to produce for thirty years.

There are three distinct types of " dwarf " coconut palms, which are recognised by the colour of the fruits, namely, apricot, green, and ivory-green. The last-named type is the most productive.

In certain parts of Malabar, during the last two years a large number of young and nearly mature nuts were found to have dropped from the palms after heavy rain (*Mem. Dept. Agric., India, Bot. Ser.*, 1924, **13**, No. 4). On inspection, these fallen nuts were seen to be diseased and as the symptoms are similar to those of " Mahali " disease of areca palms, this coconut disease has been given the same name. The attacked nuts are dark brown or blackish-brown at the base. The discoloured patches in some cases are confined to the basal region of the nuts, while in others they extend nearly half-way up the fruits. Newly fallen nuts have a whitish filmy growth of fungus over the brown patches. On opening a diseased nut, the husk is found to be soft and rotten in those places where it is discoloured externally ; the kernel is soft and partly or wholly rotten, smells very unpleasant and is unfit for human consumption. Under the microscope, it is seen to be infested with the mycelium of a fungus. Sometimes the stalks of the fruit and the nut branches are affected, with the result that all the nuts on the diseased bunch fall off, although unaffected themselves.

Cultures of the fungus isolated from diseased nuts showed it to resemble in every respect *Phytophthora* *omnivora* var. *Arecæ*. Inoculation experiments with this culture produced positive results in the case of coconuts either growing *in situ* or gathered. With areca palms, similar inoculations produced all the symptoms of "Mahali" disease of areca palms, thereby showing that the fungus causing this nutfall of coconut palms is the one responsible for areca "Mahali" disease.

The control measures are those in force for areca palms similarly attacked. All the diseased and rotten stalks and nuts should be removed and burned. The bunches might also be sprayed with Bordeaux mixture just before the rains, and again after the rains.

It should be noted that coconut palms are only affected by this disease when they are growing close to areca palms.

Blocks of coconut palms at Cedros, Trinidad, have recently become suddenly affected with an epidemic disease (*W. I. Comm. Circ.*, 1924, **39**, 506). The tallest trees have been the worst affected. The leaves are broken about 18 to 24 in. from the tip and the terminal part turns yellow, then brown and finally dies. After this, dry rot appears in the remainder of the leaf, and proceeds down the midrib to the base. In very bad cases, the crown of the leaves turns brown and the stems suffer from bleeding. The cause of this disease is attributed to storms. For control, badly affected palms should be destroyed, as they quickly develop bud-rot, while in the case of those less attacked, the diseased leaves should be cut back to healthy tissue and the surfaces tarred. Treatment of the crowns of surrounding trees with Bordeaux mixture might be carried out as an additional precaution.

Ground-nuts.—The present position of the ground-nut industry in Australia is reviewed in a recent number of the *Industrial Australian and Mining Standard* (1924, **72**, 353). The bulk of the Australian crop is grown in Queensland, Northern Territory, and in the northern part of New South Wales. The seed is sown in October to December and the nuts are ready to harvest four or five months later. It is considered that the industry badly needs re-organisation. In the first place, as a general rule, the wrong variety of ground-nut is grown, the greater proportion being Red Spanish. The markets of Sydney and Melbourne, however, require White Spanish or large White China variety for their roasting trade. The Red Spanish variety is similar to the White Spanish except that the kernels of the former type are covered with dark red skins, and are somewhat bitter and slightly yellow. In addition, they are not so suitable for roasting, for which purpose most of the imported ground-nuts are used. The large White China variety has not been grown on a large scale in Australia to compete with the imported nuts, as it is claimed that the soil in practically all the areas under this crop is very dark red or chocolate-coloured, which stains the shells badly, so that the product is at a disadvantage in comparison with the clean, bright shells of the imported nuts. Where this variety has been grown on areas with light soil in Australia, the quality of the crop has been practically equal to that of the imported kinds. As a result of the cultivation of the wrong type, there was an over-production of four to five hundred tons in 1924.

To improve the position of this industry in Australia, many growers have combined to regulate the prices and to induce the Custom Authorities to prohibit the importation of the large White China nuts, on which there is at present a tariff of 4*d.* per lb. Such an embargo is stated to be unnecessary if the growers will cultivate the variety required by the consumer, and will reduce the cost of production by the use of modern machinery and up-to-date methods and be satisfied with a fair profit. Some growers ask as much as £56 per ton for their produce, while others have expressed willingness to put large areas under cultivation if they could be guaranteed a price of £20 to £25 per ton on rail or boat. The cost of production per acre is given at £6–£8, the cost of land at £8 per acre, and the yield per acre as 16 cwts.

For use for oil extraction, the Australian growers must deliver their nuts at a maximum price of £17 10*s.* per ton at the mills if the locally produced oil is to compete with the imported English or Japanese oil. The prospect in this direction is not bright, especially in view of the fact that if the area under cotton is increased largely, cotton seed will probably be available in sufficiently large quantities to meet the local demands for a vegetable oil.

Oil-Palm.—With a view to the utilisation of the vast oil-palm areas in the Gold Coast, in which palm fruits are allowed to waste each year to the value of £1,000,000, and to meeting successfully the competition which will arise in a few years from the Dutch East Indies, the present position of the oil-palm industry of the Gold Coast has been thoroughly surveyed and the question of its development considered by the Government. A Gold Coast official publication, entitled *Correspondence relating to the*

Development of the Oil-Palm Industry, has [illegible] been issued, which includes various official correspondence written between the end of 1920 and the early part of 1923.

This publication deals with the subject in three sections. The first is confined to the question of power-driven factories on a communal basis and improved transport facilities. After a careful consideration of the question in all its aspects, the Director of Agriculture recommended that, as far as concerned the Krobo Country, Eastern Province, the Government should not take any active steps until the cost of materials and the requirements became more stabilised and the market for the produce could be gauged with greater accuracy, and that, as an inducement to European capital, the Government should be prepared to provide facilities for cheap transport in the form of a narrow-gauge railway from the mills to the main railway system. An estimate for a mill to work 2,500 tons of fruit per annum is given, entailing a capital of £20,000.

Further consideration showed that such a railway could not be provided for several years, but in the meantime the roads are being improved and extended for motor traffic.

The second section deals with the preservation and cultivation of the oil-palm. Felling the palms for palm wine is causing the destruction of hundreds of trees each year, and this practice is increasing owing to the prohibition of trade spirits. Moreover, the greater profit derived from cocoa cultivation than from the exploitation of the palms for palm oil and kernels, causes the natives to have little interest in the conservation of their palm forests. Various methods are being tried to induce the natives to preserve and cultivate the oil-palm. One of these is the formation of one or two Government plantations where the farmers can be educated regarding the advantages of the systematic cultivation of the palm and the collection, preparation, and sale of the products. With a view to preventing the wholesale felling for palm wine, the introduction of tapping is suggested, but the success of this project is doubtful, owing to its entailing more labour and to the fact that the resulting wine is not considered of such good quality. The Director of the Royal Botanic Gardens, Kew, suggested that areas should be set apart in which trees could not be felled without permission, but the Director of Agriculture considered such reservations unnecessary and not of assistance towards the rejuvenation of the oil-palm industry.

The final section is concerned with the scientific investigation of the oil-palm, and consists chiefly of two memoranda on this subject in relation to West Africa, drawn up respectively by the Royal Botanic Gardens, Kew, and the Imperial Institute, at the request of the Secretary of State for the Colonies; in these memoranda attention is drawn to the various problems requiring investigation.

FIBRES

Cotton

French Colonies.—An account of the position of cotton growing in the French Colonies has been prepared recently by M. A. Noguès, Director of the Colonial Cotton Association in Paris (*International Cotton Bulletin*, September 1924).

M. Noguès explains that for the purpose in view the Association issued a detailed questionnaire to the Governors-General and Administrators of the territories concerned, and also to local Chambers of Commerce and agricultural organisations, so as to obtain the fullest and most authoritative information available. The replies received were not in every case as complete as could be wished; but the results of the enquiry enabled M. Noguès to compile an extremely interesting report on the position, which is of much importance in view of the present dependence of the French cotton industry almost entirely on foreign sources of supply.

Conditions differ greatly in various Colonies as regards the extent of the areas suitable for cotton, the quantity consumed locally, modes of cultivation, methods of ginning, transport facilities, etc., and some Colonies are thus much more advanced than others as present or prospective sources of supply of cotton for export. Much is, however, being done by local authorities, in conjunction with the Association, to stimulate cotton-growing where the conditions are favourable, and very encouraging improvement is taking place in many districts. Further progress will depend largely on the provision of ginning facilities, both in the form of hand-gins and the further installation (where the prospects justify the expense) of ginning factories, of which there are now several in the more advanced countries (e.g. the French Sudan and Togoland). The cultivation is at present carried on for the most part merely as a native industry, and the crops grown are in several Colonies still confined to indigenous varieties of cotton.

Apart from a certain amount of long-stapled cotton of Egyptian type produced on irrigated lands in North Africa and also near Timbuctoo, and regarding which no definite figures were available, the commercial output of ginned cotton in 1923–24 was estimated at some 9,000 metric tons (or about 45,000 bales) as compared with about 900 tons in 1914. This increase is rightly regarded by the Association as a justification of its efforts and a good augury for the future. The total of 9,000 tons was made up as follows :

Territory	*Tons.*	Territory	*Tons.*
French Sudan	900	Cameroons, French Congo, etc.	100
Upper Volta	500	Oceania (New Hebrides, New Caledonia, etc.)	800
Ivory Coast	300	Madagascar	50
French Guinea	2,000	French Guiana and Antilles	50
Dahomey	500	Indo-China	3,000
Togoland	800		

Of the West African output included above, only about a third was shipped to France (the remainder being utilised for local needs), whilst the cotton produced in Indo-China was all consumed in the Far East. The production of the other regions mentioned was exported to the European markets.

Immense areas in Senegal, the French Sudan, Syria and other lands under French rule are regarded as suitable for the crop, and it is hoped that in the future a very large production of exportable cotton may be found possible in these territories.

Some years ago, O. F. Cook, of the Bureau of Plant Industry of the United States Department of Agriculture, pointed out that exotic cottons when planted for the first time in the United States showed remarkable changes in their behaviour (*Bull.* No. 256, 1913, *Bureau of Plant Industry, U.S. Dept. Agric.*). As an example of this, it was mentioned that the Kekchi type of Upland cotton of eastern Guatemala, which in its native country produces a low, early, dwarf type of plant, when grown in Texas forms a large, leafy bush owing to the fruiting branches having been more or less completely replaced by vegetative branches. Many other changes also occur in the form and texture of the leaves, the structure of the involucre, the number of carpels, and the length and abundance of the lint. These changes, termed " new-place effects," are due merely to a temporary suppression of the normal characters. In five or six generations the expression of the normal characters is re-established and the Kekchi cotton returns to its original condition of fertility, and yields fibre equal in both quality and quantity to that of the original Guatemala stock.

Similar changes have recently been recorded by J. Vuillet, Inspector-General of Agriculture in French West Africa (*Revue de Botanique Appliquée*, 1924, **4**, 330). Observations were made in the French Sudan on the American variety known as Acala. Parallel experiments were carried out with seed of this variety (1) imported direct from California and (2) produced in the previous season by plants grown in the French Sudan from imported Californian seed. The plants from (2) showed an increase in the size of the bolls and in the number of bolls with five loculi, and thus exhibited a tendency to return to the original type. It is hoped that this tendency will be accentuated in succeeding years.

These observations are confirmed by the fact that in the lacustrine zone of the Niger Valley plantations of Egyptian Sakellaridis raised from locally grown seed are distinctly finer than those produced from seed recently imported.

Nyasaland.—Reference to the position of the cotton-growing industry of Nyasaland in 1923 is made in the *Rep. Dept. Agric., Nyasaland Protectorate for* 1923. The area devoted to the crop in that year by European planters was 20,948 acres, as compared with 26,545 acres in 1922, and the production amounted to 9,932½ cwts. The lowness of the yield per acre was due to the prevalence of the red boll-worm (*Diparopsis castanea*) which caused an unusual amount of damage.

The cultivation of cotton by the natives showed a striking development owing to the fact that the Cotton Buying Agreement with the British Cotton Growing Association came into force during the year. This agreement empowered the Association to purchase all the native-grown cotton on joint account with the Government. The Association thus have control of the whole of the native crop, which is purchased at prices arranged in advance by the Department of Agriculture and the Association. The scheme worked well during 1923, and the amount of seed-cotton purchased from the natives increased to 747 tons from 387 tons in 1922, the growers receiving £13,500 as against £7,092 in the latter year. The returns of seed-cotton from the various districts of the Protectorate during the two years were as follows:

District.	1922. *Tons.*	1923. *Tons.*
Lower Shire	253	477
Chikwawa	4	75
Neno	22	48
Matope	—	5
Palombe	65	61
Ncheu	11	37
Fort Johnston	12	14
Karonga	20	30
Total	387	747

During the year, the industry had the benefit of the services of Mr. H. C. Sampson, C.I.E., B Sc., and his staff, which were provided by the Empire Cotton Growing Corporation. The Corporation has opened a cotton experiment station at Naisi which is to be used chiefly for testing local and imported strains of cotton with a view to the production of improved seed for distribution. The Corporation Entomologist is engaged in studying the red boll-worm and other cotton pests.

With a view to elucidating the seasonal prevalence of the red boll-worm, the Government Entomologist examined about 24,000 flowers and bolls between March and July which were received week by week from certain important European estates. The conclusions arrived at from this investigation, taken in conjunction with the results of experimental field-work, indicate that the red boll-worm can be best controlled by the reduction of the first brood. This can be effected by vigorous hand-picking at the very beginning of the season or by the removal of the whole of the first crop of young bolls and buds. The work is being continued and the possibility of trap-cropping with early-sown cotton will also be investigated.

Queensland.—Reference has been made in this BULLETIN (1924, **22**, 499) to the controversy which has been taking place in Queensland on the subject of the ratooning of cotton plants. The question of the relative quality of cotton from annual and ratooned crops has now been studied by the British Cotton Industry Research Association, and a paper entitled "The Quality of Ratooned Queensland Cotton," by Frederick Summers, B.A., M.Sc., has been issued as No. 25 (1924) of *Shirley Institute Memoirs.*

The investigation was carried out on two samples of Durango cotton obtained from Queensland by the Empire Cotton Growing Corporation. One of them was derived from the ordinary annual crop, whilst the other was obtained from plants from the same seed, grown in the same locality in the previous season, and subsequently ratooned.

The ratooned cotton was less lustrous than the annual, and determinations of the measurable characters of 200–250 fibres of each of the two samples gave the following average results :

		Annual.	Ratooned.
Lint length	Unmercerised	1·33 in.	1·24 in.
Hair width	Mercerised	14·00 μ	14·29 μ
,, ,,	Unmercerised	17·61 μ	17·86 μ
Wall thickness	Mercerised	5·96 μ	5·92 μ
,, ,,	Unmercerised	4·40 μ	3·76 μ
Breaking load	Mercerised	4·82 grams	5·16 grams
,, ,,	Unmercerised	4·46 grams	3·77 grams
Hair weight per cm.	Unmercerised	0·00159 mg.	0·00149 mg.
Convolutions	Unmercerised	5·8 per mm.	6·0 per mm.

These results indicate that the ratooned cotton was slightly shorter than the annual, and had a rather greater diameter, a smaller weight per unit length, and a larger number of convolutions per unit length. The thickness of the wall, although showing little difference in the mercerised fibres, was much greater in the case of the unmercerised fibre of the annual cotton than in that of the ratooned. The strength of the mercerised fibre was rather greater in the ratooned cotton than in the annual, whilst that of the unmercerised fibre was considerably greater in the annual cotton. It was also found that the length of staple was more regular in the annual cotton than in the ratooned.

Commenting on the results, the author expresses the opinion that " with the exception of the slight increase of strength on mercerisation, the comparison is entirely against the ratooned sample." It is pointed out, however, that the " results are only true for the particular Queensland samples under discussion. The ratooned sample was described as the best possible obtainable, the general quality of the ratooned crop being much inferior, but quality depends in so great a measure upon the weather conditions prevailing while the boll is maturing that it is not outside the bounds of possibility that, under other climatic conditions than those of Queensland, ratooning might be employed to produce a successful crop."

Some discussion in connection with ratooned cotton took place at a conference which was held in Melbourne in September 1924, and is recorded in the " Report of Proceedings of a Conference between Representatives of the Commonwealth and State Governments and of the

Growers, Ginners and Manufacturers in regard to the Improvement of the Cotton Industry in Australia."

It was stated by Mr. Geo. A. Bond, a cotton manufacturer of Sydney, N.S.W., that when the ratoon question first arose his firm purchased about 60,000 lb. of ratooned cotton from Queensland. The fibre was used for spinning ordinary counts, from 16's to 30's, and was found to behave in exactly the same way as the " A " grade Queensland cotton, no one in the establishment being able to detect any difference. Subsequently the firm purchased about 400,000 lb. of ratooned cotton from New Caledonia and this appeared to be slightly superior to the " A " grade of Queensland and was of longer staple.

The Chairman (Senator the Right Hon. G. F. Pearce, P.C.) read a cable from the High Commissioner in London relating to samples of Queensland ratoon cotton submitted by Mr. Daniel Jones to the Manchester Cotton Association. The High Commissioner stated that the President of the Association had reported by cable that the sample of ratoon Upland did not seem as even running in staple as annual cotton. It would make more waste which would depreciate its value, but was " by no means uncommercial." The President added that it seemed to him that the action of the Queensland Government was a restriction on enterprise, and that he would be pleased to have deliveries of ratoon cotton so that proper tests could be made and comparison made with other growths.

With regard to this report the Chairman stated: " That is not the opinion of a man who is hostile, as you will notice by the comment regarding the action of the Queensland Government, but he certainly recognises a difference between ratoon and annual cotton, to the disadvantage of ratoon cotton."

Salvador.—Cotton has been grown in small quantities in Salvador for some years. In 1924 the cultivation was undertaken on a large scale, and an account of this development by H.M. British Consul at San Salvador has been published in the *International Cotton Bulletin* (December 1924, p. 229). Great encouragement has been given to cultivators, and the banks appear willing to lend generous financial assistance. It is estimated that about 3,000 acres are now devoted to cotton in the western part of the country and probably over 30,000 acres in the eastern district. An average yield of 400–500 lb. per acre is anticipated. The variety most generally planted is Acala, which has a staple length of $1\frac{1}{8}$–$1\frac{1}{4}$ in. and has been grown successfully in the Imperial Valley, California. The seed is sown during the latter half of the rainy season (from the beginning of July to the middle of September) and picking commences in November. It is stated that in the eastern part of the country labour is scarce and wages are rising. Moreover, the cotton-picking season synchronises with the coffee harvest and there will therefore be a great demand for labour at that time. A successful cotton industry, however, would make the country less dependent on the coffee crop. There is little local demand for cotton and most of the crop therefore will be exported.

Tanganyika.—The progress of the cotton-growing industry in this country is recorded in the *Rep. Dept. Agric., Tanganyika Territory, for the fifteen months ended March 31st*, 1924.

The agricultural instruction given by native instructors in the different districts, and by officers of the Department of Agriculture at the cotton markets, at distributions of seed, and in touring their districts, has resulted in the better sorting of the cotton brought to the Government markets, where it is sold in three different qualities (based on cleanness). The quantity of seed distributed to the natives amounted to 481¼ tons in 1923, and to 1,047 tons in 1924. An effort is being made to introduce ploughing among the natives, and an experiment is being carried out in the sub-district of Shinyanga with the object of testing the adaptability of the native to this departure from the long-established custom of hand-cultivation. The result has been the ploughing of 500 acres of land by the natives, and a request for 320 more ploughs for use in the next cotton season. The native cultivators are enthusiastic and the training station is being kept filled by men voluntarily coming forward for instruction.

In 1921, the only seed available to the Department of Agriculture which had just been formed was the deteriorated seed found in the country at the close of the War. In 1922, fresh seed was imported from Uganda and distributed in certain districts. In 1924, the new seed had been distributed to all parts of the territory except the Kilwa district, the western part of the Rufiji district, and the small cotton areas on the Tanga Railway. The supplies from the 1924 crop will be more than sufficient to permit of the total elimination of the old seed. The quality of the cotton produced has shown a decided improvement.

Selection work is being carried out at the Mpanganya Cotton Station in the Rufiji district; plants were also chosen at different points in the Morogoro district, selections from which were to be grown in 1924.

The system of auction markets has proved very successful and, by encouraging the natives, has been largely responsible for the increased sowings for the 1924 crop. Supervision of the sales by agricultural officers has assisted in establishing among the natives the practice of sorting the seed-cotton as it is gathered.

Trials of different varieties of cotton, and experiments to determine the most favourable time for sowing and the effects of different spacing on yield and quality, are being carried out at the Morogoro and Mpanganya Agricultural Stations.

The Tanga district has generally been regarded as unsuitable for cotton, but in view of the desire of the inhabitants to grow the crop experimental plots were started in a number of different localities in 1923, and in a few additional places in 1924. The results show that cotton should not be planted in the Usambara Hills, but can be cultivated profitably on the fertile lands along the southern base of the hills. There is little doubt that the coastal belt would prove unfavourable.

The following table gives the amount of ginned cotton obtained from the crops of 1922 and 1923. The whole crop is grown and harvested within the calendar year, but as the ginning extends into the following year, the returns are made under the heading of the two years.

Cotton Lint Production (by Districts)

District.	1922–23. *lb.*	1923–24. *lb.*	Difference per cent.
Morogoro	832,970	1,717,301	+ 106
Mwanza (including Shinyanga) .	1,160,685	1,807,337[1]	+ 56
Rufiji	269,493	264,814	− 2
Lindi	218,032	261,546	+ 20
Bagamoyo	77,504	73,373	− 5
Kilwa	39,796	124,905	+ 214
Dar-es-Salaam	152,080	104,899	− 31
Tanga, Usambara and Moshi .	99,192	200,745[2]	+ 102
Pangani	4,950	1,716	− 65
Mahenge	15,334	17,068	+ 11
Totals	2,870,036	4,573,704	+ 60

[1] *Ginning not completed;* 33,000 *lb. included as estimate for unginned remainder.*

[2] *Tanga and Usambara,* 154,330 *lb.*; *Moshi,* 46,415 *lb.*

The yellow stain disease of cotton which is fairly widespread in Tanganyika Territory has been reported on by Mr. R. C. Wood, Cotton Specialist of the Empire Cotton Growing Corporation. It is due primarily to a fungus, which has been identified as *Eremothecium* sp., and is introduced by the cotton-staining bugs when puncturing the bolls. The disease (an internal boll disease) causes the lint to become yellow and extremely weak, particularly in the lower part of the boll and in close proximity to the seed. That the disease is due to the cotton-staining insects has been confirmed by an experiment carried out at Mpanganya. Two sets of plants were enclosed in wire gauze cages, and into one of these sucking bugs of different kinds were introduced from time to time, whilst the other served as a control. At the end of the season all the bolls from the control plants were healthy, whereas those from the plants in the other cage were practically all stained.

United States.—The Pima cotton in Arizona has been affected by a disorder, termed "crazy-top" or acromania, the most prominent feature of which is a change in the form of the branches at the top of the plant. The upper branches of affected plants are usually stronger and more upright than the normal horizontal fruiting branches developed from the lower joints of the same stalk, and this abnormality may be regarded as a suppression of fruiting branches or as a partial transformation of fruiting branches into vegetative branches. In most cases the whole plant is sterile. An account of a study of the disease has been given by O. F. Cook, of the Bureau of Plant Industry, United States Department of Agriculture, in an article entitled "Acromania or 'Crazy-Top,' a Growth Disorder of Cotton" (*J. Agric. Research*, 1924, **28**, 803).

The disease has been attributed to exhaustion of the soil and to a supposed "running out" of the Pima variety, but neither of these theories is adequate, as it has been found that the malady is not confined to Pima cotton, or to particular types of soil, or to lands that have borne cotton previously. The disease is actually more severe in Upland cottons, and causes not only abnormal branching and sterility, but also reduction and distortion of the leaves and floral organs. Moreover, the Upland cotton plants do not recover or return to more normal behaviour in the later part of the season as is the case with the Pima variety.

The crazy-top disorder is probably associated with the mosaic diseases, as the symptoms and mode of occurrence are similar, and further knowledge may lead to the discovery of means of restricting the injuries. It is possible that the infection may be carried by insects from some of the native wild plants or weeds which are related to cotton. If the cause of the infection can be definitely ascertained, it may be possible to prevent t luction of the disease into the cotton fields or its injurious effects in other ways.

Reference has been made previously in this BULLETIN (1922, 20, 237) to the encouragement given to farmers by the United States Department of Agriculture to organise themselves on a community basis for the improvement of their cotton and the ginning and marketing of the crop on co-operative lines. This system involves the cultivation of one variety only by each community and the adoption of uniform cultural methods.

An account of the organisation of one-variety communities and the means adopted to ensure supplies of pure seed for planting is given in *Farmers' Bulletin*, No. 1384 (1924), *U.S. Dept. Agric.* It is pointed out that a fundamental requirement of the American cotton-growing industry is the production of an adequate supply of pure seed of standard varieties to replace the mixed stocks now generally grown from seed obtained from the ginneries. Even when superior varieties are introduced, the stocks rapidly deteriorate owing to the seed being mixed at the ginneries with that of other varieties grown in the same district. This difficulty can be overcome by the co-operation of cotton growers in planting and maintaining only one variety of cotton in each community. The organisation of such communities enables the planters to produce fibre of a uniform character and saleable at higher prices than those obtained for the uneven cotton of mixed variety communities. The yields may be increased as well as the prices, owing to the use of better seed, improved methods of cultivation, and the more effective control of the boll weevil and other pests.

Another form of co-operation among cotton-growers, viz., co-operative marketing, has been developed in the United States during the last few years, and its methods of organisation and co-operation are described in *Trade Information Bulletin*, No. 288, *U.S. Dept. Commerce* (issued as a Supplement to Commerce Reports, November 1924). This bulletin, entitled "Marketing Cotton for Export," describes the manner in which shipments of cotton are handled and financed from the time the fibre leaves the hands of the grower until it arrives at the mills for consumption. Several possibilities of improvement in the methods of shipping, storing and financing are indicated. Regarding co-operative marketing, it is predicted that although less than 10 per cent. of the cotton exported from the United States is marketed by co-operative methods, the system will eventually play an important part in the solution of cotton-marketing problems. It was first started by the individual States organising separately. Only two or three of these State associations were in operation during the 1921 crop season, but eight were at work in 1922 and, for certain purposes, such as standardising methods, centralising sales and other activities, they were co-ordinated into the American Cotton Growers' Exchange. The Exchange now includes twelve State associations, a co-operative association handling Mississippi long-stapled cotton, and a cotton-growers' association in Arizona.

In view of the interest which has been aroused in the Union of South Africa in connection with the cultivation of Pima cotton under irrigation at Rustenburg (see this BULLETIN, 1924, **22**, 80), it may be worth while to draw attention to *Farmers' Bulletin* No. 1432 (1924), *U.S. Dept. Agric.*, which describes the methods employed in growing this variety in the Salt River Valley, Arizona. It gives valuable information on the subject, including particulars of the selection and preparation of the land, planting, thinning, irrigation, harrowing, and the harvesting of the crop.

Victoria.—In view of the desire of farmers in the Murray Valley to ascertain the possibilities of cotton as a crop on their lands under wheat-growing conditions or even under irrigation, a series of trials has been carried out by the Department of Agriculture at Wahgunyah and the results are recorded in *Journ. Agric., Victoria* (1924, **22**, 688).

The trials were designed to determine (1) the best time for planting ; (2) the number of waterings required, and the best time for applying them ; (3) the varieties best suited to the locality ; (4) the most profitable manures and the time at which they should be applied ; and (5) the most suitable spacing and thinning. The yields of cotton were small, owing apparently to the exceptionally unfavourable seasonal conditions prevailing, and only a small portion of the crop was of first quality. The highest yield obtained was 300 lb. of seed-cotton per acre, in the case of the early variety, Acala.

It is considered from the results of these experiments that cotton-growing on a large scale in districts comparable to Wahgunyah is not at present warranted, but that cotton might prove a useful subsidiary crop to the Murray

Valley farmer if early-maturing varieties were grown and watering judiciously controlled.

West Indies.—An interesting note on the "Factors Influencing the Control of Cotton Stainers (*Dysdercus* spp.)" by C. L. Withycombe, of the Imperial College of Tropical Agriculture, Trinidad, has appeared in the *Bulletin of Entomological Research* (1924, **15**, Part 2, 171).

A study of *Dysdercus howardi*, Ballou, in Trinidad has shown that the control of the pest depends essentially on the recognition of two facts. (1) The insects do not visit the cotton plants in large numbers until the bolls begin to open, at which period they are attracted to them by the exhalation of a volatile substance from the interior of the boll. (2) Infestations of the cotton crop by large numbers of the stainers are traceable to distinct migrations, consisting largely of small, or dark, or otherwise non-typical forms. The percentage of these has been observed to be as great as 62 and may often be still greater. The *D. howardi* migrants feed and lay eggs on the ground among the cotton plants, the resulting broods being typical, pale, and generally fairly large. These attack the young bolls and render the greater part of the crop worthless owing to the spread of boll-rots with which they infect it. The first crop of bolls, however, which served to attract the migrant stainers should be in good condition, as boll-rots cause little damage to ripe or nearly ripe bolls.

The author concludes that, under present conditions, cotton can only be grown in Trinidad if the planter is prepared to make all his profit on the first yield and then plant elsewhere ; the infested crop should be destroyed and some non-malvaceous crop substituted for it.

General.—An interesting paper on "Rain-grown Cotton and Climate," by E. E. Canney, B.A., of the British Cotton Industry Research Association, has recently appeared as No. 24 of the *Shirley Memoirs* (Vol. III, 1924), and has also been published in the *Journ. Text. Inst.* (1924, **15**, 1533).

It is pointed out that in considering the extension of cotton-growing without artificial irrigation to new areas, attention should be primarily directed to the climate, as this constitutes the one unalterable factor in the situation. A general survey has therefore been made of this factor with a view to obtaining an indication of the world's potential capacity to produce rain-grown cotton.

The meteorological limits for successful cotton-growing have been ascertained by a careful study of the records of uncertainty and failure which have been published. Special emphasis is laid on the question of cloudiness, a factor which hitherto has not received due consideration, and it is suggested that excessive rainfall and cloudiness and insufficiency of sunshine, especially during the ripening period, merit as much attention as questions of adequate water supply and warmth.

Three maps have been prepared, (1) indicating degrees of rainfall, cloudiness, and temperature, (2) showing zones climatically suitable for cotton-growing and zones with one unfavourable climatic element (specified in each case), and (3) showing areas with an altitude of 3,000 ft. or more (3,000 ft. being, as a rule, the greatest altitude at which cotton can be grown).

From the results of this study, it is inferred that the most promising regions in the British Empire for rain-grown cotton are the south of the Sudan, Northern Provinces of Nigeria, the valleys of the Limpopo and the Zambesi, South Africa, and the 200-mile strip of coast on the east and north of Australia, provided that the right type of cotton for each climatic zone is found. The results also indicate that the area in the more suitable climates of the world is probably at least as large again as that at present devoted to rain-grown cotton.

Appended to the paper is a list of references to data bearing on the subject.

In a paper on the "Length of Cotton Fibre from Bolls at Different Heights on the Plant," by Thomas H. Kearney and George J. Harrison, of the Bureau of Plant Industry, United States Department of Agriculture (*J. Agric. Research*, 1924, **28**, 563), it is stated that there is a current belief that, in long-stapled cottons, fibre from the first picking is shorter than that from later pickings. This belief is supported by measurements reported by Kearney in 1913, which showed that, in the case of the Yuma variety of Egyptian cotton, fibre of the second picking was on the average $\frac{1}{16}$ in. (1·6 mm.) longer than fibre from the first picking.

The fibre of the first picking is taken from bolls on the lower fruiting branches, whilst the later pickings are largely obtained from bolls on the higher branches. It therefore appeared of interest to determine the length of the fibre from bolls situated at different heights on the plant, and results are now given of such determinations on Pima cotton grown at the U.S. Field Station at Sacaton, Arizona. These show a steady increase in fibre length from the lowest group of bolls to the highest but one; the highest group showed a slight decrease in length of fibre as compared with that immediately below it. It is therefore concluded that the bolls borne on the lower fruiting branches produce shorter fibre than those situated higher on the plant.

Another series of determinations was made with a view to ascertaining whether there is a consistent relation between the length of the fibre and the date of the opening of the flower from which the boll is developed, regardless of the height of the branch on which the boll is borne. The data obtained, although too limited to render any generalisation safe, indicate that the length of the fibre is affected less by the date of flowering than by the height on the plant of the fruiting branch on which the boll is borne.

Sisal Hemp

Caicos Islands.—In this BULLETIN (1924, **22**, 51) reference was made to efforts which have been made in the past to produce sisal hemp in the Caicos Islands. It is stated in *Col. Rep. Annual, No.* 1213, *Turks and Caicos Islands for* 1923, that the industry has now revived to some extent. Although no fibre was exported from the Islands in 1921, shipments were made in 1922 and 1923, valued at £946 and £2,168 respectively.

Tanganyika.—The following information regarding the sisal hemp industry of Tanganyika is given in the *Rep. Dept. Agric., Tanganyika Territory, for the* 15 *months ending* 31*st March*, 1924. The exports of the fibre during the years 1913, 1921, 1922, and 1923 were 20,834 tons, 7,923 tons, 10,224 tons, and 12,845 tons respectively. The decline in production after the War was due to the enforced neglect and abandonment of the plantations, but a rapid recovery is now taking place. The production in different districts of the territory in 1923 was as follows: Tanga and Usambara districts, 9,394 tons; Lindi district, 1,642 tons; Dar-es-Salaam and Morogoro, 1,509 tons; Pangani, 201 tons; Mwanza, 99 tons.

TANNING MATERIALS

Lagerstroemia spp.—The tanning properties of certain Burmese species of *Lagerstroemia* have been studied by E. Pasupati and J. A. Pilgrim, and the results are recorded in the *Indian Forest Records* (1924, **10**, Part V). Analyses have been made of the fruits, leaves, twig bark, stem bark, and wood of *L. villosa, L. Flos-reginae, L. macrocarpa,* and

L. tomentosa, and tanning trials have been carried out. Of these various products, five fruits, six leaves, three barks, and possibly one wood appeared likely to be of value. Five of these materials yield an extract containing over 60 per cent. of tannin and the others an extract containing between 55 and 60 per cent. The wood which seemed promising is that of *L. villosa*, which has similar properties to certain European oak woods but gives a better yield ; it is suggested that it might perhaps be used in admixture with local woods of this class for the manufacture of extract.

Mangroves.—An investigation of the tanning properties of the mangroves of South Tenasserim, Southern Burma, has been carried out by J. A. Pilgrim and the results have been published in the *Indian Forest Records* (1924, **10**, Part X).

The work consisted of the analysis, and particularly of the determination of the tannins and soluble non-tannins, of the fruits, leaves, twig bark, branch bark, stem bark, branch wood, stem wood, and in some cases the bark of the aerial roots of the following mangroves : *Heritiera* spp., *Carapa obovata*, *C. moluccensis* and other species, *Rhizophora mucronata*, *R. conjugata*, *Ceriops Candolleana*, *Bruguiera gymnorhiza*, *B. caryophylloides*, *B. parviflora*, *Aegialites rotundifolia*, *Sonneratia Griffithii*, *Excoecaria Agallocha*, and *Avicennia officinalis*. In each case, small-scale tanning trials were carried out in order to ascertain the nature and quality of the leather furnished by the material.

The results are compared with those previously obtained by the author in an investigation of the mangroves of the Sundarbans of Bengal. It is found that there are no very wide differences between the mangroves of the two countries, but it is noted that the best of the mangroves (*Carapa moluccensis*) and the commonest of them (*Rhizophora mucronata*) are both richer in tannin in the case of the Burma trees.

The mangrove-covered area in the Tenasserim Circle provides an inexhaustible supply, the trees extending along the coast nearly the whole distance from Tavoy to Victoria Point and reaching far inland along the creeks and rivers. There are also large detached " islands " of mangrove where the trees cover low deposits of silt in the backwaters, between and behind the higher islands.

The author discusses the possibilities for the establishment of a factory for extract manufacture, and suggests that a suitable site would be found in the vicinity of Bokpyin. Information is supplied regarding the local conditions at this place, including those relating to labour and fuel.

MINERALS

Asbestos

New Zealand.—In a departmental report by J. Henderson, Geological Survey Branch, Mines Dept., New Zealand, published in the *N. Zealand Journ. of Science and Tech.* (1923, VI, p. 120) it is stated that chrysotile asbestos has long been known to occur in the basic and ultrabasic rocks of the Upper Takaka River basin. The report deals with an area lying on the western side of the Takaka River, about six miles north of Mount Arthur, which has been cleared of forest and where many cuts have been made through the surface soil in order to ascertain the distribution and economic possibilities of the asbestos veins.

The veins are arranged more or less concentrically around spheroidal masses of serpentine ranging in diameter from a few feet to more than a chain, and the vein-bearing rock forms a shell of from 6 to 30 in. thick. In the western part of the area the veins are more irregular. The author ascertained that the amount of fibre in the asbestos-bearing shells was roughly 10 to 25 per cent., very little of which exceeded 1 in. in length, most of it being under ½ in. It is stated that whilst the fibre-bearing rock could readily be separated from the barren serpentine, much of the latter would have to be moved in working the deposits; and until considerable prospecting has been done by means of adits it will not be possible to draw any conclusions as to the likelihood of creating a successful commercial enterprise. The deposit could be cheaply and advantageously worked by quarrying, but the district is not at present easily accessible.

Asbestos is also known to occur abundantly in other neighbouring areas which have not yet been properly prospected.

Bentonite

Canada.—*Publication No. 626, Mines Branch, Canada,* by H. S. Spence, which deals with bentonite, is by far the most complete account of the distribution, characteristics, and uses (both actual and potential) of this variety of clay which has yet appeared. A summary of the properties and general distribution of bentonite was given in this BULLETIN (1922, **20**, 344), but it now appears that similar clays are known in Manitoba in Canada, and in California, Tennessee, Kentucky, and Alabama in the United States.

In spite of the large amount of experimental work which has been carried out on bentonite, its true constitution has not yet been established. A number of leading mineralogists in the United States, however, are convinced that it has a crystalline structure and is probably the mineral leverrite ($2Al_2O_3$, $5SiO_2$, $5H_2O$; orthorhombic), the particles of which are said to be of greater than colloidal dimensions and to have a micaceous structure. Spence, however, adheres in this report to the colloidal conception of bentonite.

Bentonite is said to result from the alteration of an original volcanic ash by hydration of the very fine particles of glass, the ash having probably fallen as a fine dust into shallow water, and coagulation having been finally achieved by means of an electrolyte.

It is pointed out in the chapter on uses that whilst on theoretical grounds bentonite appears to have vast economic possibilities, it must be remembered that the deposits are situated far from industrial centres, that the mineral is seldom colourless or free from grit, that the latter is expensive to wash out in practice, and that the materials with which bentonite would naturally compete are comparatively cheap and plentiful. It is, therefore, considered unlikely that any great demand for bentonite will arise in the near future unless some special uses can be discovered for it.

The publication concludes with a list of patents covering certain uses for bentonite and a full bibliography of American works referring to this mineral and to the technology of colloidal clays.

Coal

China.—George D. Hubbard writes a preliminary report on some coals from Szechuan, China (*Econ. Geol.*, 1924, **19**, 641). Coal occurs in the eastern half of the province in rocks of Palæozoic age. In this region, long ago designated the " Red Basin " because of the predominant colour of its rocks, are ten more or less parallel anticlinal folds, each of which has coal, continuous along the folds. When the Palæozoic strata of these ten folds were flexed into anticlines, the coal was also bent, and erosion has exposed it on each side as a steeply inclined seam, or, in some folds, as two or three seams, that dip under the Mesozoic horizontal " Red Beds." All mining is in the folded rock, and is carried on by crude native methods without the use of machinery. The coal seams are 3 to 6 ft. in thickness.

Of 17 samples tested, 2 were cannel coal, 3 sub-anthracite, and 12 bituminous; 12 of them were good coking coals. The heating value of the coal (5 samples only) varied between 12,707 and 9,072 B.T.U., and the percentage of ash from 7·56 to 35·33, the latter figures corresponding to the higher and lower heating values respectively.

At present there are hundreds of small mines along the flanks of the folds which furnish coal for local smelting, for some small iron furnaces, for pottery and roof-tile burning, for brick-making, for manufacture of coke, and for domestic consumption.

Copper

Northern Rhodesia.—The territory in Northern Rhodesia, granted for mineral exploration by the British South Africa Co. to Rhodesian Congo Border Concession, Ltd., for five years from February 1923, consists of about 52,000 sq. miles. As the name of the company suggests, it is a part of Rhodesia, and is bounded on its north-west side by the Belgian Congo. The western boundary is a line roughly N.-S. for about 200 miles north of the junction of the Kabompo and Dongwe rivers, the southern boundary largely following the Dongwe and Lukanga rivers.

According to the report of the company's consulting engineer, Mr. P. K. Horner, dated December 17, 1924, 47 mineral discoveries had been made in eighteen months' prospecting, a small part only of the concession having been explored.

The most important mineral area so far discovered is the N'Changa, which is about 15 miles from Tshinsenda and 70 miles from Bwana M'Kubwa, both on the Rhodesian Railway. On it are the N'Changa, Dambo, Luano, Chingola, and " New Discovery " deposits. The area consists of a series of metamorphic formations, apparently forming the basin of an igneous area. The copper-bearing formation is generally a shale, but movements, intrusions, etc., have resulted in producing various types of deposit : (*a*) shales themselves, carrying oxidised copper deposits near the surface and sulphides in depth, as in the lower part of the Dambo ; (*b*) surface deposits of disintegrated shale carrying oxides of copper, as in the upper part of the Dambo ; (*c*) crush zones, mineralised by solutions from below, and oxidised near the surface, as in the N'Changa main lode ; (*d*) probably a contact deposit, as the Luano.

The N'Changa ore-body, a mineralised crush zone, so far as developed is 800 ft. long by 100 to 140 ft. wide. Over 200 ft. in depth of oxidised ore has been proved by shot drilling ; sulphides are found below this depth. It has been estimated that 500,000–600,000 tons of ore would be developed per 100 ft. of depth, the probable copper content, as judged from surface operations, shallow shafts and boreholes, being about 4·5 per cent. One trench, over 140 ft. in length, showed 5·5 per cent. of copper.

The development programme includes the sinking of four shafts to 200 ft. depth ; cross-cutting at the 50, 100, and 200 ft. levels, and driving east from No. 1 shaft and west from No. 4 shaft, to find the length of the strike.

The Dambo, 1,000 yds. to the south of the N'Changa, contains a large tonnage of low-grade ore, in an area ½ mile long by 350 ft. wide. Surface trenching and 2 boreholes, one of them to a depth of 520 ft., have shown an average copper content of about 2 per cent. The Chingola deposit, about 6,000 yds. S.W. of the N'Changa, is similar to the Dambo, but much larger.

The " New Discovery " is about 2,500 yds. to the S.W. of N'Changa. Boulders, 10 ft. across, carrying 12 per cent. of copper, and immediately resting on a decomposed shale, are being disclosed by the removal of overburden, and suggest the proximity of a high-grade ore-body. Two shafts are being sunk.

The Luano, 2,500 yds. to the S.E. of N'Changa, is apparently a contact deposit between metamorphic and igneous formations. The cutting of excellent ore in the No. 2 shaft has recently been reported.

The " Eastern " or " Porphyry " area, at the extreme S.E. of the concession and 15 miles long by 2 miles wide, is in a granite-porphyry country. In it are a number of primary copper deposits at intervals over the total length. It is stated that there is every indication that considerable widths of payable ore will be developed at a number of points. A diamond drill is now at work. At the bottom of a 100 ft. shaft on the Mushiwemba property, the full face values of the ore at the ends of east and west drives, at distances of 20 and 15 ft. from the shaft, were 6 and 2·4 per cent. of copper respectively.

In the " Southern " area, which is about 120 miles S.W. of N'Changa and in the centre of and near the southern boundary of the concession, are a number of copper deposits, some of them having been worked by former prospecting companies. The district is stated to warrant extensive prospecting.

Various alluvial and lode gold deposits, manganese

and graphite deposits, have been found in the concession and are being examined.

Canada.—The Independence copper mine of the Coquihalla area, British Columbia, is described by C. E. Cairnes (*Mem.* 139, *Geol. Survey, Dept. Mines, Canada,* 1924, p. 160). The principal workings are approximately 5,400 ft. above sea-level. The ore deposits occur in fracture zones in granite-porphyry—a portion of a batholith which has intruded slates, quartzites, schists, greenstones, etc., of Tulameen age (? Triassic). The ore deposits are found near the contact with the Tulameen group. The principal gangue is altered granite-porphyry, and the chief gangue minerals include calcite, quartz, and sericite. The chief ore mineral is chalcopyrite, but pyrrhotite and pyrite are also abundant, and molybdenite has been observed in small flakes disseminated through the country rock. The surface ore is said to have yielded 20 per cent. of copper, but the ore on which the value of the deposits depends yields only about 3 per cent. of copper. Gold to the value of about $1 per ton is associated with these ores. The chalcopyrite has been slightly enriched to chalcocite and cuprite. Blende and tetrahedrite occur in very small proportions. The ore-bodies are regarded as replacement deposits of the Butte type.

There have been no mining developments since 1908.

United States.—T. S. Lovering describes a magmatic chalcopyrite deposit of Park County, Montana (*Econ. Geol.*, 1924, **19**, 636). The deposit is at Goose Lake, 10 miles N.E. of the Yellowstone National Park, but the mine is at present idle.

Pre-Cambrian granite is here cut by intrusive rocks, provisionally called Tertiary. The ore occurs near a gabbro stock seamed by basic pegmatites, and is regarded by Lovering as a late phase of the magmatic differentiation, which gave rise to the intrusives already mentioned. The ore-body consists of a chalcopyrite-syenite, and is made up essentially of the sulphide and an intergrowth of orthoclase and albite. Accessory minerals are muscovite, biotite, apatite, and magnetite. Average samples of the ore assay 2·85 oz. of silver and up to 2 dwts. of platinum per ton. No gold is present in the ore.

Gold

Southern Rhodesia.—The Shamva mines of Rhodesia have already been briefly described in this BULLETIN (1924, **22**, 234). A report on these mines by J. Malcolm

Maclaren, which has been published recently (*Mining Mag.*, Dec. 1924, p. 329), deals fully with the nature of the gold deposits.

A series of felspathic quartzites, grits and conglomerates forms the country rock of the ore-bodies. Intrusive rocks, mainly porphyries, occur in two elongated masses, one to the S.E. and the other to the N.E. of Shamva Hill. After a long interval, auriferous impregnation followed these intrusions. Pegmatite and dolerite intrusives followed, leaving the ore-bodies practically unaffected. The known ore-channels of the Shamva mine are: (*a*) the Shamva Hill complex, comprising the South Parallel, Eastern, and No. 7 ore-channels; (*b*) Tilley's; and (*c*) Cymric. The most important of these is the No. 7, which appears to have been the feeder of the Eastern and South Parallel channels. The main ore-body is formed to the N.W. of the intersection of the No. 7 and the eastern channels. The line of intersection plunges steeply to the W.N.W., and the main ore-body in depth is expected to conform in pitch to that line. The typical Shamva ore-channel is from 100 to 250 ft. wide. Towards its margin it becomes increasingly siliceous. The centre is largely composed of calcite. Good ore is often denoted by the occurrence of numerous criss-crossing fine veinlets of calcite. In the siliceous margin the tenor of gold is generally less than ½ dwt. per ton. The rock, in passing towards the centre of the ore-channel, becomes less siliceous and more highly impregnated with calcite. The gold-content tends to rise through 1 or 2 dwts. until ore is reached, which may yield 2·75 dwts. and more per ton.

The Shamva quartzite consists largely of quartz, felspar, and mica; it is now believed to be of sedimentary origin; Maclaren concludes that the auriferous impregnation has travelled from W. to E. and that the future of the mine is westward down No. 7 channel.

The present depth of the mine is about 1,000 ft. The total ore reserves at the end of 1923 were estimated at 1,852,000 tons, of value 3·4 dwts. of gold per ton.

Canada.—The principal gold mines of the Coquihalla Area, British Columbia, are described by C. E. Cairnes (*Mem.* 139, *Geol. Survey, Dept. Mines, Canada,* 1924, p. 133).

The principal gold deposits occur in, or are intimately associated with, the Ladner slate belt (? Jurassic) which has an average width of 2½ miles and occupies a somewhat irregular synclinal depression between coarsely crystalline batholithic and Cretaceous sedimentary rocks to the N.E., and basic intrusives to the S.W.

The Emancipation mine is the most important of a series of properties along or near the slate contact to the S.W. The ore occurs in quartz veins, which lie on each side of, or dip across, the slate-greenstone contact. The Dyke vein, whose width averages less than 18 in., is entirely in greenstone and has supplied some very high grade ore. The gangue is a turbid quartz with a little calcite and albite, streaked with inclusions of country rocks and with concentrations of sulphide particles. The most prominent ore mineral is arsenopyrite, with which is associated free gold in fine particles; pyrite, pyrrhotite, and chalcopyrite are sometimes locally abundant. The parallel Boulder vein is entirely in slates and averages 8 ft. in width. It is composed of massive milky quartz sparingly mineralised by individual sulphide particles, and low in gold content. Between these two veins is a network of quartz stringers. The mine is being worked by an adit 1,200 ft. above the railway.

At the Aufeas mine, at Wardle Creek, the ore deposits occur in well-defined fissure veins, varying from a few inches to several feet in thickness, or as a network of veinlets, following a sheared and crushed quartz-diorite. The ore consists of massive arsenopyrite with some chalcopyrite and pyrite in a quartz and calcite gangue. Both the arsenopyrite and chalcopyrite carry gold. A sample of the solid arsenopyrite gave, by assay, 1·05 oz. of gold and 0·63 oz. of silver per ton.

There is a light aerial tramway on the mine, but shipment of ore has been postponed until cheaper freight rates can be secured.

Various properties along the newly-discovered gold-bearing belt of Quebec have already been referred to in this BULLETIN (1923, **21**, 535; 1924, **22**, 88, 372 and 508). The first annual report of the Arntfield Gold Syndicate, which possesses claims of the belt in the township of Boischatel, has been published recently (*Canadian Min. Journ.*, Dec. 5, 1924, p. 1196).

The gold contents are found in a schistose and mineralised zone of intrusive rock, striking about E.-W. and dipping N.55°. The intrusive rock consists of mineralised quartz-carbonate vein dykes occurring in and with mineralised syenite and syenite-porphyry dykes, all intruding into the Keewatin (pre-Cambrian) rhyolite and greenstones. The mineralised zone has an average width of 150 ft., and has been traced for a length of 5,000 ft.

Other parallel ore-zones occur on which little work has been done at present. The average value of the main mineralised zone is given as about $5 per ton, the average width being 17·50 ft. The value of the south ore-zone varies from $2·8 (width 5 ft.) to $12·60 (width 2 ft.)

During the summer of 1924, the mineralised zones were explored with the diamond drill, 11 pilot holes being put down at intervals along the strike of the main zone, and 1 hole along the strike of the south zone to depths varying from about 200 to 400 ft. The result of the work of the year has shown that there is an unusually long mineralised deposit running diagonally across the group carrying gold wherever trenched and drilled throughout its length. Some of the trenches and bore-holes show a commercial grade of ore over good widths. The assay results, taken in conjunction with the physical and geological features, indicate that high-grade ore may be found with further trenching and drilling. The best hole, No. 5, gave an average of $9.20 over a width of 9 ft. at a depth of 210 ft.

Some promising gold-bearing veins have recently been discovered in the township of Bourlamaque in the eastern part of the belt (*Canadian Min. Journ.*, Dec. 5, 1924, p. 1191). The original discovery, known as the " A " vein, has been uncovered for about 100 ft. in length, showing 12 ft. in width of heavily mineralised quartz and schist with visible free gold in places. The gold contents are very erratic, running in value from $2 to $1,500 per ton. The vein has been traced by cross-trenches for a length of nearly 1,500 ft.

About 1,000 ft. west of the above, the " B " vein has been uncovered and exposed for 35 ft. in length, and found to consist of 7 ft. of solid quartz which assays in value from $35·20 to $61·80 per ton. Beyond the quartz, 2 ft. of schist gave an average value of $16·20. A hoist and compressor have been erected and a shaft is now being sunk to the 100-foot level. As the veins in the district run E.–W. this one may prove to be an extension of the " A " vein.

About 200 ft. south of " A," a vein of quartz and schist, averaging 15 ft. in width, has been trenched for 500 ft. in length. Free gold is abundant through the quartz.

About 300 ft. south of the " B " vein, a solid body of quartz and schist, averaging 20 ft. in width, has been exposed for 400 ft. in length. The ore assays in value $7 to $9 per ton. A shaft is now being sunk to the 100-foot level.

Several other veins, or extensions of veins already discovered, are being opened up in this district, the developments in which have so far been encouraging.

United States.—Ernest Howe describes the gold ores of Grass Valley, California (*Econ. Geol.*, 1924, **19**, 595). The veins occur in a small batholith of grano-diorite or quartz-monzonite, which is an outlier of the main mass of the Sierra Nevada intrusions, occurring in sediments of the Caliveras formation and rather basic igneous rocks, porphyrite and " diabase " (dolerite). There are several systems of vein fissures. The most pronounced trend N.–S. and dip W. 25° to 30°. Another system has the same strike and dips E. A third system trends E.–W. and dips N. 25° to 30°. A fourth has the same strike and dips S. In addition, there is a vertical barren system of vein fissures (known as " crossings ") which cut nearly all the veins. The principal veins lie in the granodiorite or porphyrite-diabase. The auriferous veins consist of quartz and a little calcite and varied amounts of sulphides. Of the last, pyrite is the most abundant, while chalcopyrite and blende are present in moderate amounts, and a little galena is closely associated with the gold in the richer ore. The ore occurs in shoots which lie at or near the intersection of two vein fissures, the longer axes of which pitch in the general direction of the dip of the vein. The typical vein-filling consists of more or less crushed and altered country rock and quartz from a few inches to 8 or 10 ft. in width. The quartz is usually in the centre, and is separated from the walls by fractured country rock. Within the quartz are angular or sub-angular fragments of country rock.

Howe believes these to be replacement deposits.

Iron

India (Mysore).—In *Records of the Mysore Geological Dept.*, 1922, **21**, pt. 2, recently published, is a Report by B. Balaji Rao, Assistant State Geologist, on some iron ore deposits in the Shimoga district of Mysore.

The examination of this district was undertaken with the object of finding high-grade iron ore, low in alumina, to supplement the Kemmangundi ores, some of which are high in alumina; it was also desired to find siliceous iron ore and fluxing material in the neighbourhood of Bhadravati.

Several siliceous iron ore deposits were found and examined in the Kumsi, Shankargudda, and Hebbe areas, each of which proved to be either too low in iron, or too high in phosphorus. The Hebbe area, however, is worth further investigation. A deposit in the Shankargudda area contains ore carrying from 57 to 60 per cent. of iron and very little alumina, but the phosphorus content is high.

The Chattanhalli iron mines, about 4 miles N.E. of Kumsi, have been opened on a large deposit of low silica iron ore of good quality. The soil in the area immediately adjoining the ore-body is black and manganiferous.

The ore-body itself forms a thick capping to some low rises, and consists chiefly of earthy and hard limonite. It varies in texture, massive hard limonite being concentrated towards the centre, whilst its outer edges are laterite.

Analyses of samples gave an average of 55·34 per cent. of iron, with moderate amounts of alumina and silica, and a low phosphorus content. Analyses of samples from trial pits and surface outcrops showed on the average: iron, 54, silica, 6, and alumina, 3·9 per cent., while phosphorus was low in all cases.

The outcrop has a length of about 2,500 ft. and a width of 450 ft. at the centre and at the western end, and about 200 ft. at the eastern end. The quantity of good ore available in the Shankargudda area is said to be large.

Small shipments of ore to Shimoga have been made already, and about 10,000 tons were awaiting shipment at the time of the inspection.

Magnesite

Manchuria.—Part of the area containing the immense magnesite deposits, originally discovered in southern Manchuria in 1913, is described by K. Niinomy in *Economic Geology* 1925, **20**, 25 (an abstract of his paper read to the Society of Economic Geologists, New York Meeting, May 1924).

The deposits, which are stated to rival those of Central Europe in richness and extent, are the property of the South Manchuria Railway Co., and are situated chiefly in the Sheng-king province in the Liao-Tung peninsula, occupying an area of about 23 sq. miles east of the town of Ta-shih-chiao and north of the important port of Dairen (Dalny). The magnesite is crystalline, of medium to coarse texture, and white like that of Washington, U.S.A., and Canada. But it is not, as in these countries, intimately associated with basic igneous rocks. It occurs in the upper Takushan series (Algonkian), and is associated with quartzite, thin schists, limestone, and dolomite. Most of the deposits lie in the lower or white part of the dolomite and are usually associated with thin layers of slate or schist. An indistinct banding, sometimes noticeable, is due to streaks of graphite.

Numerous analyses which are quoted show that a great amount of magnesite of good quality is present. There are a large number of separate deposits, the five chief of which together occupy an area of more than 600 acres, the largest having an estimated thickness of about 3,000 ft. The author estimates the probable quantity of magnesite present in the area described at over 200 million tons. Comparatively little development has yet taken place, but the rock is quarried at several localities. A plant for producing calcined and dead-burned magnesia has been erected at Pan-lung-shan, and a kiln for dead-burning magnesite at Dairen. The products have been used for making refractory bricks and for lignoid floor cement, but no figures of output are quoted.

Oil Shales

Great Britain.—The oil shales of Somerset are described in a paper by H. G. Shatwell, Alfred W. Nash, and J. Ivon Graham (*Journ. Inst. Petrol. Technol.*, 1924, **10**, 872).

The presence of bituminous shale in the Lower Lias of Somerset, and in rocks of similar age along the South Wales coast (north side of the Bristol Channel), has long been known to geologists, but the shale has only quite recently been studied from an economic standpoint.

The Somerset oil shales extend for some 10 to 12 miles along the coast, running W. to E. from the vicinity of Blue Anchor, and appear as black to brown shales, alternating with bands of argillaceous limestone, to a distance of from 1 to 3 miles inland. The shale deposits are divided into two basins by the Devonian ridge of the Quantocks, viz., the Lilstock (eastern) Basin and the Doniford (western) Basin. The shale seams vary in thickness from 1 to 20 ft., and the limestones from a few inches to 2 ft. 6 in. Those exposed along the cliffs dip landward from 25° to 35° S., while the inland outcrops dip seaward from 25° to 30° N., the valleys between these being synclinal. Faulting appears as a series of fractures with downthrows to the east. The sediments—limestone, calcareous clays and marls, and oil shale—belong to the Lower Lias (Jurassic) and the Rhætic (Triassic). The authors of the paper took six samples from the Somerset deposits, which were carefully analysed and distilled, and the results were compared with those obtained from samples of the South Wales and Scottish oil shales.

Analytical determinations suggest the unsuitability of the spent shale for employment in cement manufacture. The amount of oil per ton yielded (by dry and steam distillation) was from 3·29 to 10·40 gals., the average being 7·18. The 9-in. shale from South Wales yielded 5·22 gals. and the 6 in. "shoddy," 3·61. Scottish shale yielded 22·40 gals. per ton by dry distillation and 24·14 gals. by steam distillation. The average yield from Somerset shale of ammonium sulphate per ton was a little under 5 lb. The Scottish shale gave 23·32 lb. (dry distillation). The Somerset and South Wales oil shales are characterised by an unusually high content of carbonates, the carbon dioxide averaging about 16 per cent., as compared with 1·50 per cent. in the Scottish shales. In regard to the Somerset shale, dry distillation in every case gave higher yields of oil, but lower yields of gas and ammonia. The specific gravity of a sample of crude oil (dark brown in colour) from the Somerset shales was 0·9612, and the sulphur content was 3·44 per cent.

The authors of the paper are of opinion that a full idea of the potentialities of the shale deposits can only be arrived at when samples from various parts of the field have been obtained, and their oil, gas, and ammonia yields ascertained.

Australia.—It is reported (*Petroleum Times*, Nov. 1, 1924, p. 675) that a company is being formed to work the Murrurundi deposits, situated 100 miles N.W. of Newcastle, New South Wales. It is proposed to erect Bronder retorts at Murrurundi for the treatment of these shales.

As Australia has hitherto been entirely dependent on outside sources for its supply of oil, it is to be hoped that economic methods of mining and treating its rich and vast oil shale deposits will soon be found.

Petroleum

Trinidad.—The petroleum deposits of Trinidad are described in the Imperial Institute Monograph *Petroleum* (1921, p. 35). Some particulars of recent developments are given by H. R. Berry (*Petroleum Times*, Dec. 13, 1924, p. 937).

About 90 per cent. of the present oil production is derived from the Pitch Lake area, and the remaining 10 per cent. from the Barrackpore, Guayaguayare and Tabaquite fields. In the upper Tertiary sand an excellent production is obtained between 1,450 and 1,500 ft. in depth. A lower oil horizon at 1,600 to 1,850 ft. is most prolific. Later still, additional sands have been discovered at a depth of 2,000 to 2,200 ft. The deepest boring up to the present (3,476 ft.) proved to be a dry well. The largest producer has given, so far, on an average, some 260 barrels of oil per day for nearly 5 years.

Production from the lower horizon was formerly impeded by shifting sand. The caving-in of shale and clay in the wells, thereby shutting off the oil, has now been overcome by the use of a blow-out preventer, which is screwed to the permanent string of casing set above the oil sand. The use of a preventer can be avoided, however, by drilling in with inserted pipe having no couplings, through a tightly fitted outer pipe, whereby the weight of the drilling-in string of pipe holds the packing in place.

The production of oil in Trinidad has gradually increased since 1919. In 1921, it was upwards of 336,000 tons, and in 1924 it was estimated at 360,000 tons.

Argentina.—The oilfields of the Argentine Republic are described in the Imperial Institute Monograph *Petroleum* (1921, p. 80). The results of more recent developments, given in a paper by Campbell M. Hunter (*Journ. Inst. Petrol. Technol.*, 1924, **10**, 829), are set out below under the various oilfields :

Comodoro Rivadavia : The oil-bearing formations now being exploited in this field belong to the Cretaceous. The present area over which oil prospecting operations have been conducted extends from Mangrullo to Puerto Visser, or about 60 miles in a general N.–S. direction. Oil has actually been encountered in greater or less quantity over an area of approximately 60 sq. miles.

From 1921 to 1923, inclusive, the production amounted to 1,296,901 cub. metres. The present combined production of the whole field is at the rate of 750,000 tons a year, and it is believed that before long the field will be producing about a million tons per annum. The Government has decided on the erection of a large refinery at La Plata with an estimated daily capacity of 2,000 tons, and on the further intensive development of the various national oil-fields.

Neuquen : This oilfield belongs to the Upper Jurassic formation. The first commercial oil was found by the Government drilling at Plaza Huincul in 1918. This well flowed initially at the rate of several tons a day, the oil being of remarkably high grade. Altogether 18 wells have been drilled in the Government Reserve at Plaza Huincul. The production from this Reserve from 1921 to 1923 inclusive has been 12,704 cub. metres. Recently, drilling operations were initiated by Argentine Oilfields, Limited, on the southern flanks of Cerro Lotena, where high-grade oil has been encountered in several wells, and the prospects of opening up commercial production appear assured. The Cia. Petroleo de Challaco has recently struck oil in the Plaza Huincul district, immediately west of the Government Reserve at a depth of about 2,370 ft., at which depth the well flowed at the rate of 30 to 50 tons per day.

Mendoza : This oilfield belongs to the Rhætic (Triassic) formation. Near Mendoza oil is reported to have been struck in the "Victor" well at a depth of about 3,320 ft., and is said to have flowed at the rate of 50 to 100 tons per day.

Salta-Jujuy (Sub-Andean) region : The oil zone in this region ranges in age from the Upper Mesozoic to the Devonian. Numerous anticlines have been traced in this field, mostly with overturned eastern flanks, while others have double axes. In 1922, drilling operations were initiated in the Morro Quemado anticline, and oil was struck in the first well in dolomitic limestone at a depth of about 1,760 ft. The oil is black, its specific gravity, 0·960, and its viscosity at 50°C., 350·6 (Engler).

Silver

Union of South Africa.—A Transvaal silver-lead deposit is described by Percy A. Wagner (*Econ. Geol.*, 1924, **19**, 651). The deposit is one of a series of roughly parallel galena-siderite veins that have been opened up on the farms Dwarsfontein, No. 145, and Brakfontein, No. 219, some 50 miles east of Johannesburg. The deposit was discovered in 1889; workings were suspended in 1894, but were re-opened in 1919, and an up-to-date concentrating plant and smelter were erected, and for two years fairly considerable quantities of silver-lead bullion were produced. At present developments in the bottom of the mine are not encouraging and very little ore has been opened up in recent months. Most of the ore has been won from the Main or No. 1 shaft lode, which is a well-defined fissure vein that can be traced at the surface for a distance of 5,000 ft. It strikes 50° W. of N., dips S.W. 45° to 80°, and varies in thickness from 14 ft. to nothing. It has been opened up to a vertical depth of 750 ft., but as yet no workable ore has been found below 520 ft. The country rock is a medium-grained norite, composed essentially of labradorite, bronzite, diallage, and titaniferous magnetite, which towards the S.E. passes into coarse-grained pyroxenite. The primary ore consists of galena, argentite (as minute microscopic inclusions in the galena), a little native silver (primary), chalcopyrite,

pyrite, pyrrhotite, blende, tetrahedrite (?), meneghinite (?), siderite, quartz, chlorite, and dolomite. It is, as a rule, roughly banded parallel to the vein walls, or there are alternations of siderite and galena with chalcopyrite, as well as isolated patches of the last-mentioned. The principal ore minerals are galena and argentite. The workable ore occurs in irregular patches surrounded by barren siderite. It contains on an average slightly over 1 oz. of silver per short ton to each 1 per cent. of lead. The copper content increases with depth, so that the mine may eventually be worked for that metal. The mine is at an altitude of about 5,000 ft.

Canada.—The Eureka-Victoria silver mines on Silver Peak, Coquihalla Area, British Columbia, are described by C. E. Cairnes (*Mem.* 139, *Geol. Survey, Dept. Mines, Canada*, 1924, p. 151).

The principal deposits occur in veins within fracture zones in conglomerate (Lower Cretaceous), invaded by a large batholithic body of quartz-diorite (Tertiary). They often form a minor part of the zone and favour the hanging-wall side. The principal ore mineral is tetrahedrite, which is disseminated through the ore-bodies in small specks or irregular masses, rarely exceeding a cubic centimetre in size. It is associated with siderite, quartz, and pyrite. The Eureka lode is at present the most important ore-body. It can be traced for 1,400 ft., and, for the greater part of the way, the walls are solid conglomerate. The width is from 5 to 20 ft. The other ore-bodies are very similar in general character. There has been secondary enrichment which has yielded high-grade ore. The final stage of surface alteration has proved of great importance from an economic point of view. It is due to the continual seepage of surface water through certain sections of the ore-body. Surface decomposition has here attacked both gangue and ore minerals and formed a residual concentrate of silver-rich carbonates, oxides and, possibly, chlorides, from which high assay returns are obtained.

The rich silver-lead ores of Keno Hill, Mayo District, Yukon, have already been described in this BULLETIN (1921, **19**, 425; 1922, **20**, 391 and 548; 1924, **22**, 97). The latest official report on the geology and ore deposits of Keno Hill is by W. E. Cockfield (*Geol. Survey, Dept. Mines, Canada, Summ. Rept. for* 1923, Part A, p. 1).

The metamorphosed sedimentary rocks—quartzite, quartz-mica-schist and graphite schist—of Keno Hill are believed to belong to the Nasina series (pre-Cambrian). These rocks are intruded by sills and laccoliths of greenstone, and by dykes and sills of granite-porphyry and quartz-porphyry. The porphyries contain particles of the minerals of the ore-bodies, such as pyrite, galena and, occasionally, tetrahedrite, and are believed to be genetically connected with the mineralised veins. When a transverse (later) vein intersects a longitudinal vein and passes upward through a hard rock, such as quartzite or greenstone, into schist, the vein below the schist is an extremely favourable location for the formation of an ore-shoot.

Transverse vein No. 9 of Keno Hill, Ltd., has yielded 8,000 tons of high-grade shipping ore, with an average content of about 200 oz. of silver per ton. Practically no shipping ore was found below 200 ft. in vertical depth. The workings are 400 ft. in depth. In the lower half the galena is disseminated, and the ore, although of high grade, will require to be concentrated before shipment.

In spite of the fact that the high-grade ore suitable for shipment without treatment is exhausted, the camp is in a much better position at present with regard to probable tonnage than in 1920, owing to the discovery of new veins, the most important of which is the Sadie Treadwell, which has a known length of 2,200 ft. and on which workings have been carried to a depth of 300 ft. without diminution in silver content. Workings to tap the vein at a depth of 500 ft. are in progress.

The silver-lead deposits of Beaver River Area are described by Cockfield in the same *Summary Report* (p. 22). The deposits examined occur at McKay and Horseshoe Hills, about 40 miles due north of Keno Hill.

The country rocks of the district are chiefly slates, quartzites, conglomerate and limestone (probably Devonian), and greenstone, which consists both of intrusive (augite-diorite) and extrusive rocks, the latter being highly altered types of lavas and tuffs which are believed to be andesite. The ore deposits consist of veins of coarsely crystalline quartz with disseminated sulphides, chiefly galena and tetrahedrite, with some pyrite and chalcopyrite. The veins run N.–S. right across the country rock. They have been prospected at the surface, some of them being indicated only by a line of float. The samples taken contained from 4·58 to 78·20 per cent. of lead and from 0·3 to 62·10 oz. of silver per ton. The average silver content is only 15 oz., which is unpayable under present conditions in the Mayo district. Discoveries of high-grade ores have been reported on Bra[illegible]ek, east of McKay Hill.

Spain.—The argentiferous zone in L[illegible]ierra region of Spain, is described by R. F. Aguilar (Bol. 45, *Inst. Geol. España*, **5**, 3rd series, Madrid, 1924, p. 99).

The region is about 56 miles north of Madrid, on the main road to France, via Irún. The greater part of it belongs to the province of Madrid, while portions are in the provinces of Segovia and Guadalajara. The altitude varies from 3,000 to 7,000 ft.

The lodes are bedded-veins, usually conforming to the stratification of the gneiss country rock, although they sometimes cut across it. Moreover, there is a system of cross-veins which have not yet been explored. The gneiss has a shaley structure and is close to other gneisses which are nodular or cordieritic. The country rock is the same as that of Hiendelaencina (*see* Imperial Institute Monograph, *Silver Ores*, 1921, p. 79). The strike of the veins varies from N. 9° W. to N. 60° E. and the thickness from 1½ to 10 ft. The filling is quartz, pyrite, ruby silver (pyrargyrite and proustite, the former being the more abundant), and argentite. Barytes is scarce.

There is a reference to these mines as early as 1585. They were worked some years ago, but now lie dormant. The deepest (340 ft.) and richest mine was La Perla, near Montejo.

The district, in Aguilar's opinion, merits being opened up again, as it is a most promising one, and very like that of Hiendelaencina, which has been worked to a depth of 2,300 ft.

Tin

Federated Malay States.—The deep leads (older detrital tin-bearing beds) of the Kinta Valley, Federated Malay States, are described by W. E. Cameron (*Mining Mag.*, Dec. 1924, p. 276).

The bulk of the tin ore obtained in the Kinta Valley is won from recent alluvial deposits, but a very large proportion is obtained from detrital tin-bearing beds which are older than the recent alluvials and granites of the ranges. They are found to be intruded by granite (Mesozoic). The Kinta Valley is a gently undulating peneplain, about 30 miles in length from N. to S., and from 6 to 12 miles in width. The valley floor is flanked on either hand by abrupt and deeply dissected granite ranges having altitudes of from 2,000 to 4,000 ft.

The deep leads of the valley consist of a series of detrital beds formed of gravels, sands, and clays, and what appear to be interbedded tuffs and breccias, carrying alluvial tin. At the Lahat mine they have been worked for a length of some 2,000 ft. and to a depth of 300 ft. They stand nearly vertically and underlie the newer Upper Limestone, having a vertical wall of decomposed granite on the west, and beds of steeply dipping limestone on the east. On the west of the valley, beds of the same series are being worked further north at Menglembu to depths of about 120 ft., and have been proved by bore-holes to a depth of 200 ft. Here they also lie between granite and limestone. Some five miles further north, near Jelapang, similar beds are intruded and cut off by later granite. They carry sharp-angular crystalline tin from that granite in addition to rounded water-worn tin derived from the earlier granites. At Tronoh, 9 miles south of Lahat, it would appear that beds of the same series were worked to a depth of about 150 ft. They have been intruded by granite, and have been overlain unconformably by the recent tin-bearing gravels. Similar beds appear to have been worked at Gopeng, Gunong Laing Laing, and in the Tambun mine between these two places.

Cameron concludes that there is evidence that the deep lead beds are widely distributed in the Kinta Valley, and that they go down to considerable depths, and that the position of these beds in the geological sequence is a matter of extreme importance in forming an opinion as to the possibilities of their occurrence in other parts of the tin-field.

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Report on Lac Cultivation in Eastern Siam. *The Record* (October 1924, pp. 85–90). [Ministry of Commerce, Bangkok.]

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Mining and Metallurgy in Newfoundland. By D. J. Davies. *Bull. Inst. Min. and Met.* (No. 243, December 1924, pp. 8; discussion No. 244, January 1925).

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Rivista del Servizio Minerario nel 1923. Ministero dell' Economia Nazionale, Corpo Reale delle Miniere. Pp. 263, 10¼ × 7¼. (Rome: Fratelli Treves, 1924.) Price L. 15.

Annual Report of the Director, U.S. Bureau of Mines for the fiscal year ended June 30, 1924. Pp. 57, 9¼ × 6. (Washington: Government Printing Office, 1924.) Price 10 cents.

Mineral Resources of the United States in 1922: Coal, Petroleum. Ditto in 1923: Preliminary Summary; Arsenic; Asphalt and related Bitumens; Barytes and Barium Products; Bauxite and Aluminium; Bismuth, Selenium, and Tellurium; Carbon Black from Natural Gas; Chromite; Clay; Fluorspar and Cryolite; Fuel Briquettes; Fuller's Earth; Gold, Silver, Copper, Lead and Zinc in the Eastern States; Graphite; Gypsum; Lead; Lead and Zinc Pigments and Salts; Magnesium and its Compounds; Manganese and Manganiferous Ores; Mica; Mineral Waters; Platinum and Allied Metals; Quicksilver; Rare Metals (Cobalt, Molybdenum, Nickel, Tantalum, Titanium, Tungsten, Radium, Uranium, and Vanadium); Salt, Bromine, and Calcium Chloride; Sand and Gravel; Secondary Metals; Silica; Silver, Copper, Lead, and Zinc in the Central States; Strontium; Talc and Soapstone; Tin. *U.S. Geol. Surv.* (Washington: Government Printing Office, 1924.)

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Deposits of Magnesia Alum near Fallon, Nevada. By D. F. Hewitt. *Bull.* 750-*E*, *U.S. Geol. Surv.* [*Contributions to Economic Geology,* 1923–24, *Part I, pp.* 79–86.] (Washington: Government Printing Office, 1924).

Antimony Ores. By E. Halse. *Imperial Institute Monographs on Mineral Resources, with Special Reference to the British Empire.* Pp. 102, 8½ × 5½. (London: John Murray, 1925.) Price 5*s.*

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Bismuth (Statistics 1920–1922). Imperial Mineral Resources Bureau. Pp. 15, 9¾ × 6. (London: H.M. Stationery Office, 1925.) Price 6*d.*

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Cadmium (Statistics 1920–22). Imperial Mineral Resources Bureau. Pp. 9, 9¾ × 6. (London: H.M. Stationery Office, 1924.) Price 4*d.*

Cobalt: its Production and Some of its Uses. By T. H. Gant. *Chem. and Indust.* (1925, **44**, 157–161; 191–197).

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Gold. By E. J. Kenny. *Bull. No.* 7, *Geol. Surv., N.S.W.* Pp. 60, 9½ × 6. (Sydney: Government Printer, 1924.) Price 2*s.*

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On Magmatic Nickel Deposits of the Bushveld Complex in the Rustenburg District, Transvaal. By P. A. Wagner. *Mem. No.* 21, *Geol. Surv. Un. S. Afr.* Pp. 181 + map, 9½ × 6. (Pretoria: Government Printing Office, 1924.) Price 7*s.* 6*d.*

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Helium in Canada. By R. T. Elworthy. *Can. Min. Journ.* (1924, **45**, 1233–1235).

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Mica Resources of the Union of South Africa. By A. L. Hall. *S. Afr. Journ. Indust.* (1924, **7**, 798–801).

L'Utilizzazione integrale della Leucite come fonte di Allumina, di Potassa, e di Silice. By G. A. Blanc. *Giorn. di Chim. Indust. ed Applic.* (1925, **7**, 3–12).

Special Sands [Descriptions and specifications of various industrial sands]. *Repts. of Investig. No.* 2646, *U.S. Bur. Mines.* Pp. 9 (mimeographed).

NOTICES OF RECENT LITERATURE

THE FALKLAND ISLANDS. By V. F. Boyson. Pp. 414, 8¾ × 5¾. (Oxford: The Clarendon Press, 1924.) Price 15*s*.

This work is divided into four parts, of which the first two deal respectively with the history and industries of the Islands, whilst the third part describes their geology, climate and land flora. Part IV, occupying 100 pages of the book and written by a different author (Mr. Rupert Vallentin), deals mainly with the zoology of the region, and to many readers may be of even more interest than the earlier portions.

The historical section, which occupies nearly 200 pages, gives a clear account of the remarkable vicissitudes experienced by the islands during the last 400 years. Spanish, French, and Argentine interests have been involved, and at times the final incorporation of the Falklands in the British Empire might have seemed more than doubtful. Their modern history as a self-supporting Colony dates back only some 30 to 35 years, though the staple industry (that of sheep-farming) was even before then assuming considerable proportions.

These islands, with their deeply indented coasts and vast expanses of wild moorland, may be (in the words of the author) " storm-whipped, treeless and forbidding," and they may, perhaps, be destined never to support more than their present scattered population of some 2,000; but a perusal of Miss Boyson's volume will show that for the scientist and traveller they have many attractions. The severe climate has its own advantages of equability and salubrity, and even here the sun can at times "stream down from a cloudless sky"; native species of wood sorrel, myrtle, and other delicate plants, as well as familiar garden flowers introduced by settlers, relieve the monotony of the landscape; and if human beings are few, the islands and their coasts are alive with birds, beasts, and the humbler members of the animal world.

Miss Boyson gives a good account of the epic naval battle won by Admiral Sir Doveton Sturdee in 1914, through which the little Colony flashed into world-wide fame. Mention must also be made of the excellent photographs and other illustrations which the book contains, and of the useful statistical and bibliographical Appendix. The work is one which needed to be written, and it is a valuable addition to the literature of the Empire.

KENYA. By Norman Leys, M.B., D.P.H. With an Introduction by Professor Gilbert Murray. Pp. 409, 8¾ × 5¾. (London: The Hogarth Press, 1924.) Price 15*s*.

In this book the author gives a vivid description of the objects and methods of the various groups of Europeans in Kenya, official, missionary and commercial, and of the results of their activities, with special reference to the treatment of the native races.

Dr. Leys has spent some sixteen years in East Africa in the medical service, and has acquired first-hand knowledge of the subject. This he has supplemented by the use of official reports and quotations from the Press.

After an historical and general account of East Africa, and a graphic picture of the life of the country up to the end of last century, the author passes to his main theme—the exploitation of native races for the European's benefit. He has obviously endeavoured to see this question from the standpoint of the native and, in his enthusiasm, has perhaps been unintentionally unfair to the governing classes. The book is written in an interesting manner, but the views expressed are not likely to meet with general acceptance.

CEYLON, ITS HISTORY, PEOPLE, COMMERCE, INDUSTRIES AND RESOURCES. Pp. 207 + 119 + 125, 8½ × 5½. (Compiled and published by Plâté, Ltd., Colombo, 1924.)

As explained in the preface to this volume, some of the matter which it contains is taken from the Government Handbook previously noticed in this BULLETIN (1923, **21**, 410), and the book gains in authority and value accordingly. In general aspect it differs considerably from the former work, among its distinctive features being some coloured photographs. The book is divided into three sections, separately paged, the first dealing with general matters (including history) and the second with agriculture, industry and commerce, whilst the third section consists of a descriptive list of the principal persons in the Colony, both European and native-born.

The volume can be recommended as a well arranged work of reference, fulfilling the Editor's aim of producing " a reliable and concisely written illustrated book, as a guide to Ceylon and its attractions."

JAMAICA IN 1924. A HANDBOOK OF INFORMATION FOR VISITORS AND INTENDING SETTLERS, WITH SOME ACCOUNT OF THE COLONY'S HISTORY. By Frank Cundall, F.S.A. Pp. xiv + 210, 8¼ × 5½. (Kingston, Jamaica: The Institute of Jamaica. London: H. Sotheran & Co., 1924.)

This Handbook, which is in its ninth edition, may be commended to the notice of a wider public than that described in the sub-title. Mr. Cundall, who is Secretary and Librarian of the Institute of Jamaica, caters for everyone interested in the Colony and its varied history, whether able or not to make a close acquaintance with its attractions. Probably the chapters of most general interest are those devoted to the colonisation of the Caribbean region; the position of Jamaica, first as a Spanish and then as a British Colony; its natural history, and its scenery, etc., this latter aspect being presented in the form of " A Tour of Jamaica." More important, however, from particular standpoints are the sections in which the manufactures, agriculture, and trade of the Colony are described, whilst the Appendix is of value to travellers and intending residents.

Besides a number of excellent photographs the book contains several woodcuts, geological and rainfall maps, a plan of Kingston and a general map of the island.

THE ENGLISH-SPEAKING NATIONS: A STUDY IN THE DEVELOPMENT OF THE COMMONWEALTH IDEAL. By G. W. Morris, M.A., and L. S. Wood, M.A. With chapters on India and Egypt. Pp. xx + 396, 7½ × 4¾. (Oxford: The Clarendon Press, 1924.) Price 3*s.* 6*d.*

The main theme of this excellent book is, as is stated n the preface, " the development of the Commonwealth ideal and the gift to the world of the sense of imperial trusteeship—an imperial conception based upon nationality and self-government."

The first five chapters are devoted to the following subjects: the stages by which unity of race and government was achieved at home, the discoveries of the sixteenth century and the consequent development of trade and of maritime power, the early settlements in America and their subsequent loss, the struggles with France both in America and in India, and a general consideration of England's early "mercantile system" and the cause of its failure.

The following seven chapters consider the development of the individual members of the Empire and are succeeded by one dealing with the United States of America.

In the remaining three chapters the authors discuss the systems of government within the Empire, the influence of sea-power upon commerce, and the ideal which should be before the members of the British Commonwealth in their dealings with one another and with the subject races for whom they are trustees.

An appendix contains a list of Dominions, Colonies, Protectorates, and Mandated Territories, with their respective areas and populations. Suggestions are added regarding books, both general and particular, suitable for more detailed study. A useful time-chart of events in the British Isles, Europe, and America is provided and there is a full index.

Great value is added to the book by its wealth of maps, photographs, reproductions of cartoons, and other illustrations.

The book is full of valuable information and should be read by all interested in Imperial affairs.

CROP-PRODUCTION IN INDIA. A Critical Survey of its Problems. By Albert Howard, C.I.E., M.A., Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India (formerly Imperial Economic Botanist, Agricultural Research Institute, Pusa). Pp. 200, 8½ × 5½. (Oxford: The University Press, 1924.) Price 10*s*. 6*d*.

The importance of agriculture to the prosperity of India cannot be over-estimated. It is, and for many years to come must remain, her greatest industry. With a view to increasing and improving the produce of the soil of India investigations have been steadily conducted by the Imperial Agricultural Department since its institution twenty years ago. Many improvements in crop-production have been devised, which have been introduced rapidly and successfully into the fields of the cultivators. Valuable work has been done on the problems of soil erosion and aeration, irrigation, and the utilisation of alkali lands. New varieties of cotton, wheat, sugar-cane, fibres, oil-seeds, tobacco, etc., have been introduced, which have contributed largely to the well-being of the country, whilst much has been done to reduce the damage done to crops by insect pests and fungoid diseases. Besides these results, the investigations have brought to light a number of problems, the successful solution of which must be accomplished before further advances can be made. From their nature and magnitude, these questions, as Mr. Howard points out, can only be dealt with if the active co-operation of the public is secured. The first step in enlisting this interest is to set out the problems in simple language and to explain in what manner they affect the future progress of India. This is the chief aim of the present book, whilst a subsidiary purpose has been to stimulate further work and to attract a number of active and enthusiastic investigators to take an interest in the questions. There is perhaps no one better qualified than Mr. Howard to do this. He has been associated with the Department of Agriculture since its inception and his wide experience is evidenced by the fact that, in the bibliographies appended to the 21 chapters into which the book is divided, his name is absent from only three.

The book is something more than a mere statement of work done and problems to be elucidated. It emphasises to a remarkable degree the value of science to the nation and for this reason it is hoped that the book will be read not only by the scientific worker in agriculture, but by those Administrators and others who do not yet fully appreciate the proper place of science in nation-building. Much of the information is necessarily of a technical nature, but Mr. Howard has succeeded in presenting it in an extremely readable form.

COTTON IN SOUTH AFRICA. By W. H. Scherffius, M.Sc., and J. du P. Oosthuizen, M.Sc. Pp. 207, 8½ × 5½. (South Africa: Central News Agency, Limited, 1924.) Price 21*s*.

The authors of this book, who are respectively Chief and Assistant Chief of the Tobacco and Cotton Division, Union of South Africa, have been responsible for directing the recent developments of the South African cotton industry and are therefore well qualified by experience to give authoritative information on the subject. The work has been written with the object of providing a guide to cotton growers in the Union and is also intended to serve as a text-book for students and prospective planters.

The first part deals briefly with the history of cotton, the world's production, the introduction and progress of the industry in South Africa, and the cotton plant, its varieties and their improvement by selection and hybridisation. The questions of ginning, grading and marketing are next dealt with and the requirements of the cotton spinner are pointed out. The utilisation of cotton seed and its various products is discussed ; an account is given of the insect pests and diseases by which the cotton plant is attacked ; the temperature and rainfall of different parts of the Union are indicated ; and several pages of statistics, relating to production and export of raw cotton and cotton manufactures, and similar matters, are included.

The book is well illustrated with photographs and diagrams and contains several excellent maps, and it will doubtless be of much service to South African cotton planters.

TOBACCO CULTURE WITH SPECIAL REFERENCE TO SOUTH AFRICAN CONDITIONS. By H. W. Taylor, B.Agr. Pp. 176, 8½ × 5½. (South Africa : Central News Agency, Ltd. ; London : Gordon & Gotch, Ltd., 1924.) Price 25s.

This work has been written with the object of giving information on the methods of growing, curing, and handling tobacco, with special reference to the conditions existing in the Union of South Africa, Rhodesia and Nyasaland.

The early chapters consist of brief notes on the botany of the tobacco plant, on the introduction and development of its cultivation in the United States and other countries, and on the present position and prospects of the industry in the countries of South Africa.

Detailed accounts are given of the methods of cultivation, harvesting, curing, and preparation for the market of the four principal classes of tobacco, viz., bright flue-cured tobacco, dark tobacco (air-cured, sun-cured, and fire-cured), Turkish tobacco, and cigar tobacco. Large-scale plans are provided of flue barns and grading rooms, together with full specifications ; these have been prepared by A. C. Jennings, Irrigation Engineer to the Department of Agriculture, Southern Rhodesia. Soils and manure suitable for the cultivation of the different kinds of leaf are considered in the respective sections, and special chapters are devoted to insect pests, plant diseases, and seed selection.

The book contains a number of useful diagrams and illustrations, and at the end of each chapter is given a list of references to the literature of the subject.

Cane Sugar and its Manufacture. By H. C. Prinsen Geerligs, Ph.D. Second Edition. Pp. ix + 342, 9¾ × 7. (London: Norman Rodger, 1924.) Price 20*s.*

The first edition of this excellent work on the chemistry and technology of the sugar cane and cane sugar manufacture was noticed in this Bulletin (1910, **8**, 94). The advances which have been made during recent years in all branches of the subject have rendered it necessary for the book to be thoroughly revised and, in part, re-written. Considerable changes have been made in the sections on juice extraction, clarification, filtration, and the preservation of sugar and molasses, in order to bring them into accord with modern views and practice.

Modern Cereal Chemistry. By D. W. Kent-Jones, B.Sc. (Lond.), F.I.C. With a Foreword by William Jago, F.I.C. Pp. ix + 324, 8½ × 5½. (Liverpool: The Northern Publishing Co., Ltd., 1924.) Price 25*s.*

This book gives an account of the application of modern chemical theories to the reactions and changes which take place in the milling of wheat and the baking of bread. Its primary object is to introduce to the miller a new conception of the processes which he employs, in the light of modern knowledge. As an introduction, three chapters are devoted to the subjects of vitamins in flour, colloidal chemistry, and hydrogen ion concentration, respectively. These are followed by a chapter on the colloidal chemistry of flours and the baking process, while a subsequent chapter deals with the bleaching of flour and flour improvers. The remaining chapters deal respectively with the composition of wheat flour and the different varieties of wheat, the composition of mill products, conditioning, moisture in wheat and flour, and the analysis of flour. The book is intended for cereal chemists and progressive millers, a general acquaintance with elementary chemistry being assumed. Mr. Kent-Jones has succeeded in presenting the results of recent research in a very clear and readable manner, but it is to be feared that more than a cursory knowledge of chemistry will be needed for an intelligent appreciation of the contents of the book. The work, which is the first of its kind, admirably indicates systematic methods of handling an industry on scientific lines, and should encourage progress in a subject of great national importance.

COTTON-CELLULOSE: ITS CHEMISTRY AND TECHNOLOGY. By A. J. Hall, B.Sc., F.I.C., F.C.S. Pp. 228, 9¾ × 7½. (London: Ernest Benn, Limited, 1924.) Price 30s.

This work forms a useful monograph on cotton cellulose, its behaviour towards chemical reagents and its constitution, and also on the chemical processes involved in modern cellulose industries.

After a brief account of the nature, growth, structure, and composition of the cotton fibre, the methods of its purification and of the preparation of cellulose are described. The action of alkalis on cotton is then dealt with, special reference being made to mercerisation and the effect of mercerisation on the properties of cotton; the chemical nature of the changes induced by mercerisation is also discussed in the light of recent researches. Among other subjects dealt with are the behaviour of cotton cellulose towards acids, including the formation of nitrocellulose and cellulose esters; the effect of various other reagents, and the production of cellulose xanthates and cuprammonium solutions; and the action of oxidising agents and the preparation and properties of the oxycelluloses. One chapter is devoted to the principles and methods of dyeing cellulosic materials; another to a discussion of the chemical constitution of cellulose; a third to the production of artificial silks, celluloid and other materials derived from cellulose; and a fourth to methods of analysis of cotton and cotton cellulose.

An index to the authors of researches referred to in the text and a useful subject index are appended.

WATERPROOFING TEXTILE FABRICS. By Herbert P. Pearson, M.Sc. Pp. 112, 9×6. (New York: The Chemical Catalog Company, Inc., 1924.) Price $3.

The methods of waterproofing fabrics are comparatively little known and the literature of the subject is very meagre. The present work has therefore been written and affords a large amount of information regarding processes and formulæ. Most of this has not been published previously, but has been derived from trustworthy sources in the industry itself. The book is intended chiefly for the information of the user of waterproofing, but will doubtless be of service to any experienced dyer or finisher of piece-goods who wishes to embark in the waterproofing industry.

In an introductory chapter, the author points out that the term "waterproof" has been applied not only to fabrics which have been filled or coated, but also to those in the treatment of which no attempt has been made to close the pores, these having been left free to the passage of air. He prefers to restrict the word "waterproof" to fabrics of the former class and to speak of the latter materials as "water-resistant." This plan has been adopted throughout the book, the term "waterproof" meaning impervious to water and air resistant, whilst "water-resistant" implies resistant to water and porous to air.

A brief chapter of much interest is devoted to the basic principles of the subject; it is mainly concerned with the relation of resistance to penetration by water to the increased surface tension brought about by the agents employed, and shows that the deterioration with age of water-resistant fabrics is principally due to the reduction of the surface tension by the entrance of dirt into the pores.

Methods of coating and impregnating fabrics with various substances are described, and numerous formulæ are given for the preparation of suitable applications for the purpose.

The final chapter comprises a bibliography of processes and formulæ for waterproofing textiles patented in the United States, Great Britain, France, and Germany since 1900.

A number of useful diagrams and photographs are introduced to illustrate the text. The work is written in an interesting style and forms a valuable addition to the literature of textile manufacture.

ELEMENTS OF FORESTRY. By Franklin Moon, B.A., M.F., and Nelson Courtlandt Brown, B.A., M.F. Second Edition. Pp. xvii + 409, 8¼ × 5¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1924.) Price 17*s.* 6*d.*

The first edition of this book, which is intended as a general elementary text-book for students of forestry, was published in 1914 (see this BULLETIN, 1915, **13**, 179). In preparing the new edition an effort has been made to bring statistics up to date, as well as policies, which have changed considerably in many respects during the past ten years. Two new chapters dealing respectively with the development, organisation, and activities of the

National Forest Service and State forestry activities have been added. It is becoming more and more recognised in America that owing to the depletion of the natural timber resources of the country, intensive forestry must be practised on a large scale and lands now idle must be replanted and made productive. The present volume should be of great value in guiding the student along these lines.

SOIL ACIDITY AND ITS RELATION TO THE PRODUCTION OF NITRATE AND AMMONIA IN WOODLAND SOILS. By G. R. Clarke, B.A., B.Sc. Pp. 27, 11 × 7½. (Oxford: The Clarendon Press, 1924.)

This memoir, No. 2 of the Oxford Forestry Series, deals in detail with the question of the degree of acidity and its possible relationship to the variation in amount of nitrate and ammonia in a series of soils from Bagley Wood, near Oxford. Woodland soils were chosen for the investigation as representing more nearly natural conditions than could be obtained with agricultural land.

The author gives a concise account of the more important work previously published on the subject of the fluctuations in amount of nitrate present in soils, followed by a short discussion of work done on the question of soil acidity. There is a detailed description of the soils used, of the methods of sampling, and of the experimental methods tried and finally adopted for the estimation of nitrate and of total and water-extractable ammonia.

Samples of soil were taken over long periods and the following determinations made on each: water, organic matter, ammonia (both in the soil and its water extract), acidity (both as concentration of hydrogen-ion and as lime requirement), nitrate, rainfall, and temperature of air and sample at the time of sampling.

Although no definite conclusions can be drawn as regards the exact effect of variations in acidity on the production of nitrate and ammonia, owing to the number of variable factors involved, there appears to be a certain correlation between the degree of acidity of a soil and its power of accumulating nitrate and ammonia.

The paper forms an important contribution to the literature of the subject.

SOIL MANAGEMENT. By Firman E. Bear. Pp. vi + 268, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1924.) Price 10s.

The object of this book is to acquaint students in American agricultural colleges with the applications of those scientific principles which are of importance in planning rational and constructive systems of soil management and in increasing the productive capacities of soils. The book, therefore, does not enter into the more intricate details of the subject, since the majority of the students are only interested in theoretical considerations in so far as these may be of value in elucidating practice on the farm.

The book is divided into five sections, the first of which deals with the requirements of crops ; the climatic, biotic, and soil factors affecting the growth and distribution of crops, and the needs of plants with regard to mineral, nitrogen, organic, and water supplies are then considered in turn. The next section treats of the characteristics of soils, as regards origin, classification, chemical composition, and physical properties, while the importance of the relations, soil-air and soil-water, is well brought out. This is followed by a section on the utilisation of soil resources, in which the maintenance of the optimum conditions for plant growth, by proper drainage, tillage, conservation of organic matter and rotation of crops, is considered. The next section deals with the conservation of soil resources, the importance of the various elements and methods of keeping up the available supply being emphasised. In the final section, on the supplementing of soil resources, the need for the different fertilising and amending substances is discussed, and rational methods of selecting and applying fertilisers, either singly or mixed, are described.

The book is well supplied with references to literature, conveniently arranged at the end of each chapter.

Since the author is Professor of Soils in the Ohio State University, the book deals exclusively with American practice and most of the illustrative data are taken from the records of the Ohio Agricultural Experiment Station and College. The underlying general principles involved, however, are so lucidly explained that the work may be read with profit by all interested in scientific agriculture.

ORGANIC ARSENICAL COMPOUNDS. By George W. Raiziss, Ph.D., and Joseph L. Gavron, B.S. Pp. 570, 9 × 6. (New York : The Chemical Catalog Company, Inc., 1923.)

This work, which appears in the American Chemical Society Series of Scientific and Technologic Monographs, has been written by well-qualified experts, Dr. Raiziss being Professor of Chemotherapy, University of Pennsylvania, whilst Mr. Gavron is Associate in Research Chemistry, Dermatological Research Laboratories, Philadelphia.

It gives a full account of the arsenical carbon compounds; an endeavour has been made to include every substance of this type hitherto recorded and a list of references to the publications in which they were first described is given in an appendix.

The subject is introduced by a general historical sketch of the discovery of organic arsenical compounds and the development of arsenotherapy. In an appendix to the book there is a discussion of the utilisation and value of the compounds as therapeutic agents, particularly in the treatment of such diseases as sleeping sickness, malaria and syphilis. A second appendix is devoted to the methods employed in the analysis of organic arsenic compounds. In addition to the bibliography, good author and subject indexes are provided.

The volume forms a very comprehensive monograph which will be exceedingly useful to research workers in this important branch of chemotherapy, especially in view of the fact that developments during the last few years have been so rapid and fruitful that earlier treatises on the subject are now wholly inadequate.

GAS MANUFACTURE. By W. B. Davidson, M.A., Ph.D., D.Sc., F.I.C. Pp. viii + 464, with 147 figs., 8½ × 5½. (London: Longmans, Green & Co., 1923.) Price 21*s*. net.

The object of this book is to supply the gas engineer or student with a comprehensive summary of the essential principles underlying the manufacture of coal gas. The author accentuates the chemical significance of the various operations and to some extent subordinates the mechanical aspect.

The opening chapters deal with physico-chemical laws, and the chemical composition of the various products obtained at a gas-works. The manufacture, storage, and distribution of coal gas are described in a concise manner, the descriptive matter being considerably enhanced by numerous illustrations.

The concluding chapters give a useful account of the analytical control of gas-works products.

The book will prove useful to all interested in the subject.

RATS AND HOW TO DESTROY THEM. By Mark Hovell, F.R.C.S., with an Introduction by S. L. Bensusan. Pp. xlii + 465, 8¼ × 5¼. (London: John Bale, Sons & Danielsson, Ltd., 1924.) Price 10*s*. 6*d*.

The damage done by rats in Great Britain has been estimated at various amounts between £15,000,000 and

£75,000,000 per annum. These animals exist in enormous numbers and their rate of increase, if unchecked by natural or other means, is such that the progeny of a single pair would run into millions in a very few years.

The rat problem is, therefore, one of prime national importance, and a book such as this, by an author with many years' practical experience, should serve a very useful purpose. It is written from the point of view of this country, but it will doubtless also prove of value wherever rats are a menace in towns, and on farmsteads and plantations in the Dominions and Colonies.

The book touches on every aspect of the question ; it discusses the habits of rats, the different means used for destroying them, and the special problems connected with their occurrence in houses, warehouses, sewers, and gardens, on shooting estates and farms, on ships, and, it would seem, under all conditions in which they are likely to be found. There are also sections on the relation of rats to plague and cancer, and on the methods of destroying cockroaches, mice, and sparrows.

Of the various methods of destruction, trapping, ferreting, poisoning, blocking, and flooding are dealt with in great detail. There are also practical sections on fumigation, trailing, and snaring, and on the care of ferrets and dogs. The sections on virus, the mongoose, and the Rodier system consist of summaries of available information, leading in each case to an adverse judgment on the suitability of the method for general adoption.

The author makes it clear that whilst the regular use of traps is a very important means of keeping down the pest, in cases where large colonies are to be attacked this method should not be applied until the numbers have been reduced as far as possible by other means. He is careful to emphasise the necessity for concerted action, and sets out in some detail a " Scheme for the organised destruction of rats throughout Great Britain."

The arrangement of the book is rather curious. The main portion is called Part I ; the forty-five pages composing Part II consist of addenda to some of the Sections of Part I, and deal with such matters as the constructional details of traps, the setting of trap signals, and the making of ferret hutches. This plan necessitates some repetition, and the duplication of a number of illustrations, which could have been avoided by incorporating the necessary details in their appropriate places in Part I.

BOOKS RECEIVED FOR NOTICE

RICE: ITS CULTIVATION AND PREPARATION. By Charles E. Douglas, M.I.Mech. E. Pp. ix + 143, 7 × 4¾. (London: Sir Isaac Pitman & Sons, Ltd.) Price 3*s*.

SCIENTIFIC PRESERVATION OF FOOD. By Thomas M. Rector. Pp. xi + 213, 7¾ × 5¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925.) Price 10*s*.

TIMBERS OF TROPICAL AMERICA. By Samuel J. Record, M.A., M.F., and Clayton D. Mell, B.A., M.F. Pp. xviii + 610, 10 × 6¼. (New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press, 1924.) Price 45*s*.

THE SEASONING AND PRESERVATION OF TIMBER. By Ernest G. Blake, M.R.S.I., A.B.I.C.C. Pp. xii + 132, 8½ × 5½. (London: Chapman & Hall, Ltd., 1924.) Price 9*s*. 6*d*.

AGRICULTURAL CO-OPERATION IN THE BRITISH EMPIRE. Edited by K. Walter, with an Introduction by Sir Horace Plunkett, K.C.V.O., F.R.S., etc. Pp. 254, 9¼ × 6. (London: George Routledge & Sons, Ltd., 1925.) Price 10*s*. 6*d*.

THE AGRICULTURAL SITUATION: ECONOMIC EFFECTS OF FLUCTUATING PRICES. By G. F. Warren, Ph.D., and F. A. Pearson, Ph.D. Pp. xvi + 306, 9 × 6. (London: Chapman & Hall, Ltd.; New York: John Wiley & Sons, Inc., 1924.) Price 15*s*.

PRINCIPLES OF HUMAN GEOGRAPHY. By Ellsworth Huntington and Sumner W. Cushing. Third edition, revised. Pp. xviii + 430, 9 × 6¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1924.) Price 15*s*.

REGULATION OF RIVERS WITHOUT EMBANKMENTS. By F. A. Leete, C.I.E., assisted by G. C. Cheyne. Pp. xii + 122, 10¾ × 7½. (London: Crosby Lockwood & Son, 1924.) Price 30*s*.

THE TEXTILE RECORDER YEAR BOOK, 1925. Compiled and edited by Frank Nasmith. Pp. cvii + 896, 7 × 5. (Manchester: John Heywood, Ltd., 1925.) Price 7*s*. 6*d*.

A TEXTBOOK OF GLASS TECHNOLOGY. By F. W. Hodkin, B.Sc., A.I.C., and A. Cousen, M.Sc., A.R.C.Sc., A.I.C. Pp. xxiii + 551, 9¾ × 6. (London: Constable & Co., Ltd., 1925.) Price 42*s*.

BITUMINOUS SUBSTANCES. Scientific Progress of Practical Importance during the last Fifteen Years. By Percy Edwin Spielmann, Ph.D., B.Sc., F.I.C., A.Inst.P., A.R.C.Sc. Pp. xv + 206, 8½ × 5½. (London: Ernest Benn, Ltd., 1925.) Price 15*s*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

INVESTIGATIONS AT THE IMPERIAL INSTITUTE OF SAMPLES OF PLANTATION PARA RUBBER PREPARED IN CONNECTION WITH THE CEYLON RUBBER RESEARCH SCHEME

VARIABILITY OF PLANTATION RUBBER

THE fifteen sets of samples dealt with in this report constitute a series prepared by the technical officers in Ceylon at the suggestion of the London Committee in continuation of the earlier investigations of the variability of the vulcanising and mechanical properties of plantation rubber, the results of which were summarised in this BULLETIN (1923, **21**, 308). The detailed results of the earlier investigations will be found in this BULLETIN (1916, **14**, 495 ; 1918, **16**, 409 ; 1920, **18**, 1 ; 1922, **20**, 431 ; 1923, **21**, 291).

It was previously found that unsmoked sheet rubber from certain estates almost invariably vulcanised much more slowly than that from other estates (this BULLETIN, 1923, **21**, 308) and it was accordingly decided to study this question further. At the same time it seemed desirable to investigate whether seasonal variations occur in Ceylon rubber and whether differences in estate conditions, e.g. elevation, soil, climate, etc., influence the results. Arrangements were accordingly made for the preparation of sets of samples at intervals of three months on four estates in different districts from trees planted at about the same time. The estates were selected so as to represent a wide range of conditions under which rubber is grown in the island.

In order to determine whether the extent of this variability was affected by the method of preparation, the following samples representing a number of forms of rubber were included in each set: (1) thin crêpe, (2) unsmoked sheet, (3) smoked sheet, (4) sheet rubber rolled up while wet, (5) crêpe rubber blocked while wet, (6) slab rubber crêped after 14 days. In the case of each form of rubber the samples were prepared as nearly as possible under identical conditions, but owing to the restriction of production and consequent changes in tapping systems it was unfortunately not possible to adhere completely to the programme originally adopted. Moreover the conditions of smoking employed on the selected estates varied considerably.

The particulars on the next page regarding the estates were received from the Ceylon Committee.

RESULTS OF EXAMINATION

The samples were submitted to vulcanising and mechanical tests in the standard rubber-sulphur mixing (90:10), and also in a mineral mixing containing an organic accelerator in order to study the behaviour of the rubbers in this type of mixing, which is now largely employed by manufacturers. The mixing adopted was as follows: 90 rubber, 5 sulphur, 90 zinc oxide, and 1 hexamethylenetetramine (hexamine).

In both mixings tests were made at two standards of vulcanisation, one giving a definite elongation at a standard load and the other the optimum tensile strength of the rubber. Further particulars of the tests and the methods employed are given in the Appendix to this report (p. 146).

1. *Variation in Time of Vulcanisation*

(*a*) *Comparison of Samples Prepared at Different Periods of the Year.*—There is no definite evidence of seasonal variation on any of the selected estates. In the case of three of the estates the time of vulcanisation of the same

	Estate in Kalutara District.	*Estate in Kelani Valley District.*
Area	39¼ acres (approximately 100 trees per acre)	274 acres (29,078 trees)
Altitude	200–300 ft.	100–200 ft.
Rainfall (1922)	130·59 in.	119·5 in.
Date of planting	1906	1905
Yield per acre (1922)	633 lb.	454 lb. (restriction)
Time of wintering	February	February
Tapping system	Single spiral cut in half circumference from left to right. Alternate days. Changed to opposite side of tree every 6 months. Limiting height to 24 in.	Single spiral cut in half circumference from left to right. Alternate days (Sunday tapping stopped prior to preparation of 4th set of samples). Changed to opposite side of tree every 12 months. Limiting height 33–36 in. Average bark thickness 9 mm.

	Estate in Matale District.	*Estate in Uva District.*
Area	50 acres (5,332 trees)	70 acres (90–100 trees per acre)
Altitude	1,200–1,500 ft.	2,300–2,500 ft.
Rainfall (1922)	76·38 in.	76·33 in.
Date of planting	1906	1906
Yield per acre (1922)	622 lb.	437 lb. (11 months tapping)
Time of wintering	Late February	May to July (during dry weather of the south-west monsoon period)
Tapping system	Single spiral cut in half circumference from left to right. Alternate days (changed to every third day April 1923). Changed to opposite side of tree every 12 months. Average bark thickness 8 mm.	Single spiral cut in half circumference from left to right. Every third day (stopped from Oct. 1923 till early in January 1924, tapping irregular during January). Changed to opposite side of tree every 12 months. Limiting height 36–42 in. New cuts opened June 17, 1923.

form of rubber prepared at different seasons of the year is fairly uniform both in the rubber-sulphur and in the mineral accelerator mixing. The sets from the other district (Uva) are also fairly uniform in the mineral accelerator mixing but are all more variable in the rubber-sulphur mixing. On this estate tapping was exceptionally irregular as compared with the others. That this may have influenced the results is suggested by the fact that the two sets with the longest time of vulcanisation were prepared (1) shortly after the opening of a new tapping

TABLE A

Mixing—90 Rubber : 10 Sulphur

Standard Elongation—Time of Vulcanisation (minutes)

Form of rubber.	KALUTARA.				KELANI VALLEY.				
	Date of Experiment.			Average.	Date of Experiment.				Average.
	[1] June 23, 1923.	[2] Sept. 26, 1923.	Dec. 16, 1923.		Feb. 7, 1923.	[6] May 9, 1923.	[7] Aug. 23, 1923.	Dec. 3, 1923.	
Crêpe	120	140	140	133	150	140	130	130	138
Sheet	90	95	80	88	90	75	65	75	76
Smoked Sheet	110	120	100	110	115	110	123	120	117
Rolled Sheet (wet) . . .	60	72	72	68	65	65	60	60	63
Blocked Crêpe (wet) . . .	150	150	110	137	95	140	130	100	116
Matured Slab (crêped) . .	65	70	72	69	57	60	63	60	60
	Average . . .			101	Average				95

Form of rubber.	MATALE.					UVA.					Average of whole series (15 samples of each form).
	Date of Experiment.				Average.	Date of Experiment.				Average.	
	Feb. 14, 1923.	[3] May 26, 1923.	[4] Sept. 3, 1923.	[5] Dec. 29, 1923.		[8] July 4, 1923.	Oct. 13, 1923.	[9] Jan. 19, 1924.	Mar. 29, 1924.		
Crêpe . . .	140	130	140	140	138	160	140	160	130	148	139
Sheet . . .	77	100	85	80	86	130	120	115	95	115	91
Smoked Sheet .	90	110	110	100	103	145	135	120	100	125	114
Rolled Sheet (wet) .	60	70	63	70	66	90	77	80	75	81	70
Blocked Crêpe (wet)	125	130	140	135	133	123	135	150	160	142	132
Matured Slab (crêped) . .	48	75	60	60	61	80	80	90	72	81	68
	Average				98	Average				115	102

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[1] *Tapping irregular during June owing to rain.*

[2] *Tapping irregular owing to rain. New cut opened in September.*

[3] *Trees rested end of March to April 7 and tapping altered from alternate days to every third day except on day of experiment when tapped on second day—no rainfall for two months.*

[4] *Tapped on second day.*

[5] *Tapping irregular during December.*

[6] *Trees rested one month from March 20.*

[7] *Tapping irregular during August owing to rain.*

[8] *New cut opened June 17. Tapped every third day.*

[9] *No tapping between October and January.*

TABLE B

Mixing—90 Rubber : 10 Sulphur

Optimum Tensile Strength (lb. per sq. in.)

Form of rubber.	KALUTARA.				KELANI VALLEY.				
	Date of Experiment.			Average.	Date of Experiment.				Average.
	[1] June 23, 1923.	[2] Sept. 26, 1923.	Dec. 16, 1923.		Feb. 7, 1923.	[6] May 9, 1923.	[7] Aug. 23, 1923.	Dec. 3, 1923.	
Crêpe	2,640	2,300	2,450	2,460	1,790	2,550	2,280	2,350	2,240
Sheet	2,620	2,560	2,510	2,560	2,300	2,650	2,560	2,400	2,480
Smoked Sheet	2,500	2,400	2,520	2,470	2,420	2,620	2,480	2,350	2,470
Rolled Sheet (wet)	2,650	2,450	2,460	2,520	2,390	2,560	2,410	2,300	2,420
Blocked Crêpe (wet)	2,600	2,340	2,240	2,390	2,260	2,310	2,330	2,330	2,310
Matured Slab (crêped)	2,460	2,380	2,570	2,470	2,400	2,440	2,480	2,490	2,450
	Average			2,480	Average				2,400

Form of rubber.	MATALE.					UVA.					Average of whole series (15 samples of each form).
	Date of Experiment.				Average.	Date of Experiment.				Average.	
	Feb. 14, 1923.	[3] May 26, 1923.	[4] Sept. 3, 1923.	[5] Dec. 29, 1923.		[8] July 4, 1923.	Oct. 13, 1923.	[9] Jan. 19, 1924.	March 29, 1924.		
Crêpe	2,430	2,330	2,400	2,150	2,330	2,250	2,300	2,120	2,160	2,210	2,310
Sheet	2,680	2,530	2,510	2,410	2,530	2,400	2,500	2,350	2,420	2,420	2,500
Smoked Sheet	2,380	2,640	2,480	2,470	2,490	2,420	2,380	2,080	2,120	2,250	2,420
Rolled Sheet (wet)	2,660	2,520	2,490	2,420	2,520	2,580	2,490	2,250	2,410	2,430	2,470
Blocked Crêpe (wet)	2,510	2,430	2,340	2,330	2,400	2,220	2,130	2,310	2,300	2,240	2,340
Matured Slab (crêped)	2,410	2,380	2,430	2,490	2,430	2,410	2,540	2,450	2,480	2,470	2,460
	Average				2,450	Average				2,340	2,420

(*See footnotes to Table A, p.* 138)

TABLE C

Form of rubber.	Average slope.	Average elongation at load of 1·04 kilos. per sq. mm. optimum tensile strength cure.
Crêpe	38	778
Sheet	39	768
Smoked Sheet	40	766
Rolled Sheet (wet)	34	791
Blocked Crêpe (wet)	37½	778
Matured Slab (crêped)	36	794

TABLE D

Mixing—90 Rubber; 5 Sulphur; 90 Zinc Oxide; 1 Hexamine

Standard Elongation—Time of Vulcanisation (minutes)

Form of rubber.	KALUTARA.				KELANI VALLEY.				
	Date of Experiment.			Average.	Date of Experiment.				Average.
	[1] June 23, 1923.	[2] Sept. 26, 1923.	Dec. 16, 1923.		Feb. 7, 1923.	[6] May 9, 1923.	[7] Aug. 23, 1923.	Dec. 3, 1923.	
Crêpe	40	50	50	47	40	47	50	50	47
Sheet	35	40	40	38	35	30	35	40	35
Smoked Sheet	35	50	40	42	40	35	40	40	39
Rolled Sheet (wet)	35	40	40	38	30	30	30	40	33
Blocked Crêpe (wet)	40	50	40	43	40	35	37	50	41
Matured Slab (crêped)	30	35	35	33	30	30	37	35	33
	Average			40	Average				38

Form of rubber.	MATALE.					UVA.					Average of whole series (15 samples of each form).
	Date of Experiment.				Average.	Date of Experiment.				Average.	
	Feb. 14, 1923.	[3] May 26, 1923.	[4] Sept. 3, 1923.	[5] Dec. 29, 1923.		[6] July 4, 1923.	Oct. 13, 1923.	[9] Jan. 19, 1924.	Mar. 29, 1924.		
Crêpe	40	40	50	45	44	50	50	45	45	48	47
Sheet	30	35	40	40	36	40	40	40	35	39	37
Smoked Sheet	40	37	30	40	37	40	50	42	40	43	40
Rolled Sheet (wet)	30	30	28	40	32	40	35	40	35	38	35
Blocked Crêpe (wet)	40	37	37	45	40	40	40	40	45	41	41
Matured Slab (crêped)	30	37	30	30	32	35	40	40	35	38	34
	Average				37	Average				41	39

(*See footnotes to Table A, p.* 138)

TABLE E

Mixing—90 Rubber; 5 Sulphur; 90 Zinc Oxide; 1 Hexamine

Optimum Tensile Strength (lb. per sq. in.)

Form of rubber.	KALUTARA.				KELANI VALLEY.				
	Date of Experiment.			Average.	Date of Experiment.				Average.
	[1] June 23, 1923.	[2] Sept. 26, 1923.	Dec. 16, 1923.		Feb. 7, 1923.	[6] May 9, 1923.	[7] Aug. 23, 1923.	Dec. 3, 1923.	
Crêpe	2,800	2,640	2,560	2,670	2,690	2,720	2,570	2,780	2,690
Sheet	2,740	2,600	2,600	2,650	2,750	2,420	2,450	2,510	2,530
Smoked Sheet . . .	2,750	2,710	2,510	2,660	2,730	2,870	2,590	2,600	2,700
Rolled Sheet (wet) . . .	2,900	2,610	2,710	2,740	2,880	3,060	2,980	2,570	2,870
Blocked Crêpe (wet) . . .	2,600	2,480	2,560	2,550	2,670	2,820	2,500	2,400	2,600
Matured Slab (crêped) . .	2,860	2,660	2,670	2,730	2,910	2,730	2,650	2,890	2,800
	Average			2,670	Average				2,700

Form of rubber.	MATALE.					UVA.					Average of whole series (15 samples of each form).
	Date of Experiment.				Average.	Date of Experiment.				Average.	
	Feb. 14, 1923.	[3] May 26, 1923.	[4] Sept. 3, 1923.	[5] Dec. 29, 1923.		[8] July 4, 1923.	Oct. 13, 1923.	[9] Jan. 19, 1924.	March 29, 1924.		
Crêpe . . .	2,470	2,640	2,590	2,450	2,540	2,530	2,660	2,420	2,550	2,540	2,610
Sheet . . .	2,870	2,640	2,580	2,680	2,690	2,700	2,570	2,400	2,460	2,530	2,600
Smoked Sheet. .	2,900	2,600	2,670	2,810	2,750	2,600	2,590	2,810	2,770	2,690	2,700
Rolled Sheet (wet) .	3,060	2,890	2,910	2,810	2,920	2,560	2,650	2,760	2,810	2,700	2,810
Blocked Crêpe (wet)	2,800	2,630	2,280	2,460	2,540	2,420	2,560	2,620	2,480	2,520	2,550
Matured Slab (crêped) . .	2,830	2,820	2,880	2,760	2,820	2,880	2,750	2,560	2,740	2,730	2,770
	Average				2,710	Average				2,620	2,670

(*See footnotes to Table A, p.* 138)

cut and (2) after a resting period of three months. Both these factors are stated by other investigators to increase the time of vulcanisation of rubber.

(*b*) *Comparison of Estates.*—On the whole there is little difference between the times of vulcanisation of the samples from the estates in the Kalutara, Kelani Valley, and Matale districts; in the case of the samples from the Uva district the average time of vulcanisation is about 17 per cent. longer in the rubber-sulphur mixing and 7 per cent. longer in the mineral accelerator mixing. A reason for this longer time of vulcanisation cannot be definitely assigned, but the following factors may have had some influence: (1) the tapping interval was longer than on the other estates; (2) on one occasion there was a resting period of three months; and (3) a new tapping cut was opened at the commencement of the experiment. This estate is also much higher above sea-level than the others (see page 137), but it seems unlikely that the difference in altitude has affected the time of vulcanisation as the fourth set of samples in which the tapping conditions approached most closely to the standard had, on the whole, a time of vulcanisation only slightly longer than that of the samples from the other three estates.

As stated above (page 135) it was found in previous experiments that unsmoked sheet rubber from certain estates almost invariably vulcanised much more slowly than that from other estates. It will be observed that as regards the present samples the differences between the four estates are much greater in the case of unsmoked sheet and matured slab than in the other forms of rubber. The difference in the average time of vulcanisation of the samples of crêpe from the four estates is very small.

(*c*) *Comparison of Different Forms of Rubber.*—The sets of different forms of rubber can be placed in the following order as regards variability in the rubber-sulphur mixing: crêpe, smoked sheet, sheet rolled up wet, blocked crêpe, slab, and plain sheet; the crêpe being distinctly more uniform and the slab and plain sheet distinctly more variable than the others. The small variation displayed by the present sets of crêpe rubber is stated to be of no practical importance in industry except for certain specialised work.

In view of the fact that the selected estate in the Kelani Valley had the best ventilated smokehouse, it is of interest that smoking prolonged the time of vulcanisation of the samples of sheet rubber more in the case of this estate than the others. A detailed investigation of the effect of different conditions of smoking is at present being carried out by the chemist in Ceylon.

The samples of blocked crêpe previously examined (this BULLETIN, 1923, **21**, 311) had a much shorter time of vulcanisation than air-dried crêpe when tested in a rubber-sulphur mixing and were very uniform. The present sets have, however, given very irregular results. The interior of these samples was invariably dark-coloured, probably the effect of micro-organisms. It is known that the time of vulcanisation of rubber affected in this way is liable to variation.

In the mineral accelerator mixing there is little difference between the variations of the six forms of rubber, but, as in the case of the rubber-sulphur mixing, the two forms generally prepared in Ceylon, viz. crêpe and smoked sheet, are the most uniform. A full comparison of all the results obtained with the 90 samples examined shows that little difficulty owing to variability in time of vulcanisation is likely to be experienced with plantation rubber in the type of mineral accelerator mixing used in this investigation.

(d) Comparison of Results Obtained in Rubber-Sulphur and Mineral Accelerator Mixings.—(1) In the case of each form of rubber the variation in time of vulcanisation when expressed in minutes is much greater in the rubber-sulphur than in the mineral accelerator mixing. In the latter case, however, the times of vulcanisation are much shorter and, if the variations are expressed as percentages, there is little difference between the two mixings. The same percentage variation has, however, a much greater effect on the physical properties of the rubber-sulphur mixing than of the mineral accelerator mixing. It would appear, therefore, that the uniformity experienced by manufacturers in mineral accelerator mixings similar to

that used in this investigation is due to the fact that fairly uniform physical properties are obtained over a very wide range of cures.

(2) Although the variations in individual samples of rubber do not correspond in the two mixings, it will be seen from tables A and D that in both mixings:—

(*a*) The four estates fall into approximately the same order in respect of the average time of cure of the whole of the samples, the maximum difference in this respect being about 20 per cent. in the rubber-sulphur mixing and 10 per cent. in the mineral accelerator mixing.

(*b*) The different forms of rubber also fall into the same order with respect to average time of vulcanisation, the matured sheet and slab vulcanising more quickly than the unsmoked sheet, which vulcanised more quickly than the smoked sheet and crêpe. The difference between the crêpe and slab samples is about 30 per cent. in the mineral accelerator mixing and about 80 per cent. in the rubber-sulphur mixing.

These results indicate that in most cases tests in a rubber-sulphur mixing are likely to give an approximate guide to the vulcanising properties of a rubber in the type of technical mixing employed in this investigation. In view, however, of the fact that divergent results have been obtained with individual samples, it is proposed to continue tests in both these mixings. Special tests with other technical mixings used in industry are also in progress for purposes of comparison.

2. *Optimum Tensile Strength*

On the whole there is little difference in the tensile strength of the sets of samples from the four estates either in the rubber-sulphur mixing or in the mineral accelerator mixing. The samples from Uva are, however, in nearly all cases slightly weaker than those from the other districts, and this is possibly connected with their longer time of vulcanisation.

Most of the samples prepared in December and January are weaker than those prepared on the same estate at other periods of the year, but the differences are not sufficient to be of practical importance.

In previous experiments sheet rubbers rolled up wet had higher tensile strengths than other forms of rubber in a rubber-sulphur mixing at a cure giving a standard stress-strain curve. The results of the present tests show that matured rubbers yield their optimum tensile strength at a cure corresponding with the standard previously adopted, whereas other forms of rubber require on the whole a slightly longer time of vulcanisation to give the maximum tensile strength. At this cure the wet sheet and matured slab rubbers have good tensile strengths in the rubber-sulphur mixing, but are not stronger than unsmoked sheet. In the mineral accelerator mixing, however, they are stronger than any of the other forms of rubber.

In the case of each estate, crêpe rubber is weaker in the rubber-sulphur mixing than the other forms examined, but the weakness is not so pronounced in the mineral accelerator mixing.

3. *Slope*

The determination of slope has not given much practical information. In the present series of rubbers, however, a connection can be traced in the rubber-sulphur mixing between the slope and the elongation at a given load at the optimum tensile strength cure, e.g. smoked sheet, which has on the average a higher slope than the other forms of rubber, has the lowest elongation, and wet roll, which has the lowest slope, has the highest elongation (see Table C).

CONCLUSIONS

Time of Vulcanisation

(1) There is no definite evidence from this investigation that seasonal variations occur in the rubber from any of the estates, or that differences in altitude, climate or soil have any effect on variability in time of vulcanisation.

(2) The samples of crêpe are much less variable in time of vulcanisation than the other forms of rubber, of which smoked sheet is the least and unsmoked sheet the most variable.

(3) In the case of the samples of crêpe and smoked sheet there is no important difference in the time of vulcanisation of the sets prepared on the different estates.

(4) The results indicate that tests in a rubber-sulphur mixing are likely to give an approximate guide to the vulcanising properties of rubber in the type of technical mixing employed in this investigation. The variations found in the technical mixing are of much less practical importance than those observed in the rubber-sulphur mixing.

Tensile Strength

Practically the whole of the samples are of satisfactory tensile strength in both mixings, though the crêpe rubbers are on the average somewhat weaker than the other forms of rubber. The samples of matured rubber (wet roll and slab) are noticeably stronger than the others in the technical mixing, but are not distinctly superior in the rubber-sulphur mixing.

APPENDIX

The samples dealt with in the foregoing report were submitted to vulcanising and mechanical tests in a rubber-sulphur mixing (90:10) and also in a mineral accelerator mixing : 90 rubber, 5 sulphur, 90 zinc oxide, and 1 hexamethylenetetramine (hexamine). In both mixings tests were made at two standards of vulcanisation, viz. (*a*) an elongation of 775 per cent. in the rubber-sulphur mixing and 480 per cent. in the mineral accelerator mixing at a load of 1·04 kilos. per sq. mm. ; and (*b*) the optimum tensile strength.

METHODS OF TESTING

The following is a summary of the standard procedure employed in testing rubber at the Imperial Institute:

Washing

Washing machine	Diamond cut rolls
Dimensions of rolls	9 in. × 4½ in.
Speed of back roll	25½ revolutions per minute
Speed of front roll	24 revolutions per minute

It is not the general practice to wash rubber before mixing, but samples of wet rubber are crêped on the washing rolls, and then hung in a dark cupboard and dried at room temperature.

Mixing

Mixing machine	Rolls 9 in. × 4½ in.
Speed of back roll	27 revolutions per minute
Speed of front roll	21 revolutions per minute
Rubber-sulphur mixing	Rubber 540 grams Sulphur 60 grams
Mineral accelerator mixing	Rubber 360 grams Sulphur 20 grams Zinc oxide 360 grams Hexamine 4 grams

In the case of the rubber-sulphur mixing, the rubber is first put through nearly cold rolls about 2 mm. apart. The rolls are then gradually closed until they are about 1·5 mm. apart and the rubber is masticated until it forms a smooth sheet. The time occupied is usually about 15 minutes.

The sulphur is now added and worked in as rapidly as possible without allowing it to bank on the rolls. When the whole of the sulphur has been worked in, the dough is passed once through tightly shut rolls, which are then opened until 1·5 mm. apart and the dough allowed to run round until smooth and well mixed. The time occupied is usually about ten minutes. The temperature of the rolls is never allowed to rise so as to be uncomfortable to the hand.

In the case of the mineral accelerator mixing, the rubber is masticated, and the sulphur added as described above, then the zinc oxide, and finally the hexamine in the form of a solution in 6 c.c. water and 2 c.c. alcohol.

Calendering

Calender	Rolls 9 in. × 4½ in.
Speed of rolls	16 revolutions per minute

Immediately after mixing, the warm dough is run quickly through warmed calender rolls and converted into a sheet about 2·5 mm. thick which is run on to a canvas roll and kept overnight.

Moulding

On the following day the calendered sheet is cut into pieces the size of the vulcanising moulds (9¾ in. × 2¾ in.). Two of the pieces are rolled together, and the weight of the slab is adjusted to approximately 90 grams in the case of the rubber-sulphur mixing and 160 grams in the mineral mixing. The slab is then placed in the mould and covered with a thin, annealed aluminium sheet. The slab, mould and aluminium sheet are previously well dusted with powdered French chalk. The base of the mould consists of a mild steel sheet (3 mm. thick) to which a rectangular frame of mild steel (5 mm. deep) is riveted. Suitable slots are cut in the upper surface of the frame to allow excess of dough to extrude.

Vulcanisation

Vulcanisation is carried out in an autoclave press (Bridge Williams type), the lid of which is fitted with an iron tube projecting 9 cm. below the lower surface. The tube is filled to a height of about 14 cm. with oil, in which is placed a thermometer graduated to 0·2° C. The standard temperature of vulcanisation adopted is 148° C. in the open steam, which has been found to correspond to a reading of 147·8° C. by the thermometer in the oil-bath. The thermometer reading is always checked by the pressure gauge.

The autoclave is heated until the thermometer registers 147·8° C. for 10 minutes. The steam is then turned off, the press opened, and the moulds placed in position. After replacing the lid the ram is forced up by means of a hydraulic pump until the pressure is 2,240 lb. per sq. in. The steam is then turned on full until the thermometer indicates 147·8° C. (this takes about 4 minutes) and this temperature is maintained until the cure is completed, when the moulds are removed as rapidly as possible and the rubber taken out. The time of vulcanisation is taken as the interval elapsing between the turning on and turning off of the steam. During vulcanisation the exhaust valve is always slightly open to ensure a current of steam passing through.

Testing

The vulcanised slabs are kept for 72 hours. Rings are then cut from the slabs by a Schopper cutting press, and the thickness (*t*) of the centre disc measured by a Schopper micrometer. The breadth of the rings is always taken as 3·80 mm. The rings are tested on a Schopper machine in the usual way, the speed of the ram being 2·5 cm. per second. Stress-strain curves are recorded automatically for every ring tested.

The tensile strength is $\frac{\text{Breaking Stress}}{2 \times 3{\cdot}80\, t}$.

The elongation at break is read off from the machine. The other elongations are automatically recorded in the machine by an electrical method specially devised at the Imperial Institute.

At least 12 rings are used for the final tests and the average results are recorded.

THE SEEDS OF *CITRULLUS VULGARIS* AS A SOURCE OF OIL

THE water-melon (*Citrullus vulgaris*, Schrad.), believed to be indigenous to parts of equatorial Africa, is now cultivated in numerous varieties throughout all warm countries. The ripe fruit possesses a watery pulp, much appreciated, especially in dry regions, such as the Kalahari desert of Africa, whence came one of the best-known varieties viz. the Tsama water-melon. The seeds are employed as food by the natives of many countries, being sometimes ground and baked into bread, or used in the form of sauce, soup, etc., whilst in India they are said to be in demand in medicine on account of their cooling, diuretic properties. They contain an oil used by the natives as an illuminant and in cooking.

Seeds of a number of different varieties have been examined from time to time at the Imperial Institute as a source of oil. Reports on some of these have already been published in this BULLETIN, viz. on " Ikpan " seeds from the Southern Provinces, Nigeria (1907, **5**, 132 ; 1908, **6**, 356), and on water-melon seeds from the Sudan (1916, 14, 160). Samples from the Gold Coast, Sierra Leone, and the Northern Provinces, Nigeria, have been received in recent years, and these are dealt with in the following pages.

GOLD COAST

Four samples of the seed of *Citrullus vulgaris* have been received from the Gold Coast, under the name of " Neele " or " Niri " seed. The plant is grown throughout the Colony, Ashanti and the Northern Territories, but apparently seed is produced only in quantities sufficient for the local demand. The samples were as follows :

No. 1. *Neele seed from the Northern Territories.*—These seeds were small, narrow, flat, and of straw colour ; they measured ⅜ in. in length and possessed a very thin seed-coat enclosing a creamy-white kernel. Some of the seeds were smooth and shiny, and others rough.

No. 2. *Neele seed from the Northern Territories.*—These were small, narrow, flat, straw-coloured seeds, similar to No. 1.

No. 3. *Neele or Niri seed from the Western Province.*—Thin, flat, oval, yellowish-brown seeds, from ⅝ to ¾ in. in length and ⅜ in. wide. They were larger and flatter than Nos. 1 and 2, and differed from them in general appearance.

No. 4. *Neele or Niri seed* (*Akitsiwa*) *from Appolonia, Western Province.*—Flat, oval, cream-coloured seeds, differing in colour, size and form from all the previous samples.

The seeds yielded a yellow, liquid oil, varying somewhat in tint in the different samples, the percentage obtained in each case on extraction with light petroleum being shown in the following table, together with the amount of moisture present in the seed.

	No. 1. From Northern Territories. *Per cent.*	No. 2. From Northern Territories. *Per cent.*	No. 3. From Western Province. *Per cent.*	No. 4. From Western Province. *Per cent.*
Moisture in seeds as received .	7·0	6·4	8·1	8·3
Yield of oil in seeds as received .	44·4	45·3	33·8	37·2
Yield of oil expressed on moisture-free seeds	47·7	48·4	36·8	40·6

It will be seen that the two samples from the Northern Territories give practically the same yield of oil, whilst the yields from the Western Province samples differ not only from one another, but also from those obtained from the seeds from the Northern Territories.

The oils extracted from samples Nos. 1, 2 and 3 were chemically examined with the following results, compared with the constants previously recorded for water-melon seed oil.

	No. 1. From Northern Territories.	No. 2. From Northern Territories.	No. 3. From Western Province.	Water-melon seed oil.
Specific gravity at 15°/15° C.	0·9232	0·9236	0·9230	0·9143–0·9262
Refractive index at 40° C.	1·467	1·467	1·467	1·463–1·467
Acid value . . .	1·3	3·2	1·8	1·4–8·4
Saponification value .	192·8	191·3	195·1	189·7–189·2
Iodine value (Hübl, 17 hours) *per cent.*	121·7	124·3	119·2	106·0–124·0
Unsaponifiable matter *per cent.*	0·8	0·8	0·7	0·76–1·34
Solidifying point of fatty acids . . .	32·5° C.	29·2° C.	32·7° C.	26·5°–36° C.

These results show that the oils from the three samples of seed are very similar in composition, and closely resemble other samples of water-melon seed oil.

The residual meals left after the removal of the oil from samples Nos. 1 and 3 were cream-coloured and possessed no distinct taste. The results of chemical examination of the meals are given in the following table, which also shows the corresponding figures recorded for undecorticated cotton-seed cake. In the case of the Neele seed meals, the results have been calculated on the basis of 7 per cent. of fat.

	Meal from No. 1. Northern Territories.	Meal from No. 3. Western Province.	Undecorticated cotton-seed cake.[1]
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·1	9·7	13·75
Crude proteins	35·3	28·2	24·62
Fat	7·0	7·0	6·56
Carbohydrates, etc. (by difference) .	14·3	11·3	29·28
Crude fibre	29·0	39·2	21·19
Ash	4·3	4·6	4·60
Nutrient ratio	1 : 0·86	1 : 0·97	1 : 1·67
Food units	120	99	107

[1] *Smetham : "Analyst"* (1914, **39**, 481).

The Neele seed meals contained no cyanogenetic glucosides ; indications were found of the presence of a substance answering to the test for alkaloids in that from sample No. 1, but not in the case of No. 2.

Commercial Value

Neele oil would be classed as a "semi-drying" oil, and could be employed for the purposes to which such oils are usually applied. The residual meal is considerably richer in protein than undecorticated cotton-seed cake, but in view of the fact that a substance answering to the tests for alkaloids was found in the meal from sample No. 1, feeding trials would have to be carried out before it could be recommended as a food for live stock.

Samples of the seed from the Northern Territories and the oil extracted from it at the Imperial Institute were submitted to oil-seed crushers who expressed the opinion that the oil could be refined without difficulty, and should be suitable for technical use, and probably, if suitably treated, for edible purposes. The firm valued the seed at £17 to £18 per ton net weight, delivered in the United Kingdom (November, 1923), and offered to purchase a trial shipment of 200 to 300 tons.

General Conclusions

It seems probable that three different varieties of *Citrullus vulgaris* are represented in these four samples of seed from the Gold Coast, the two from the Northern Territories being apparently the same. The three forms differed in general appearance; the seeds from the Western Province yielded less oil than the others, while the residual meal from No. 3 contained less protein and considerably more fibre than that obtained from sample No. 1 from the Northern Territories. The oils from the different forms were, however, practically identical in composition.

The wide variation in appearance and yield of oil of the seeds of *Citrullus vulgaris* from different countries is well known, and in this connection it may be interesting to quote the following yields which have been recorded:

Origin of seed.	Yield of oil. *Per cent.*
South-West Africa	15·3–17·0
Formosa	20·6
Sudan	23·6
Southern Provinces, Nigeria	25·4
Belgian Congo	37·5

It will be seen, therefore, that the samples from the Western Province of the Gold Coast, although giving a lower yield than those from the Northern Territories, and also than those from Sierra Leone and the Northern Provinces, Nigeria, to be dealt with later in this article, do not compare unfavourably with those of most of the countries mentioned above.

If available in commercial quantities and at a suitable price, the seed from the Northern Territories would find a ready market in the United Kingdom. The seed from the Western Province would be of lower value on account of the smaller percentage of oil.

SIERRA LEONE

Seeds of *Citrullus vulgaris* were received from the Commissioner of Lands and Forests, Sierra Leone, under the name of "Kogai" or "Egusi," in August, 1923.

In size and shape the seeds resembled the Neele seeds from the Northern Territories, Gold Coast, but most of them were cream-coloured, and had a rough surface, whilst the Neele seeds were yellowish and smooth.

In view of the fact that the seed is employed as an article of food by the natives, it was desired that it should be analysed in order to ascertain its nutritive value. The seed was accordingly examined with the following results :

	Per cent.
Moisture	7·1
Crude proteins	34·3
Fat	44·4
Carbohydrates, etc. (by difference)	4·8
Crude fibre	6·7
Ash	2·7
Nutrient ratio	1 : 3·1
Food units	202

No cyanogenetic glucosides were present.

These figures show that Kogai seeds are rich in fat and proteins, and should therefore be of considerable value as a foodstuff.

The seed was also examined as an oil-seed. As shown in the above table, the seeds, containing 7·1 per cent. of moisture, yielded 44·4 per cent. of oil, equivalent to 47·8 per cent. expressed on the moisture-free seeds. This yield is approximately the same as that obtained at the Imperial Institute from Neele seed from the Northern Territories of the Gold Coast (see p. 150).

The oil, which was somewhat greener than the Neele seed oil, was chemically examined with the following results:

		Oil from Kogai seed.
Specific gravity at 15°/15° C.		0·9218
Acid value		17·8
Saponification value		193·7
Iodine value (Hübl, 17 hrs.)	*per cent.*	117·5
Unsaponifiable matter	*per cent.*	1·1
Volatile acids, soluble		0·15
Volatile acids, insoluble		0·4
Refractive index at 40° C.		1·4645
Solidifying point of fatty acids		33·4° C.

The results indicate that this oil is of very similar character to Neele seed oil.

The composition of the meal left after the removal of the oil is given in the following table:

	Kogai seed meal.	
	As prepared. *Per cent.*	Calculated as containing 7 per cent. fat. *Per cent.*
Moisture	10·6	9·9
Crude proteins	62·8	58·8
Fat	0·6	7·0
Carbohydrates, etc. (by difference)	8·9	8·3
Crude fibre	12·2	11·4
Ash	4·9	4·6
Nutrient ratio	1 : 0·6	1 : 0·41
Food units	167	173

The residual meal contained no cyanogenetic glucosides.

The Kogai seed meal contains an even higher percentage of protein than Neele seed meal (see p. 151), and would form a valuable feeding-stuff in admixture with other materials rich in carbohydrates.

The results of this investigation indicate that Kogai seeds are of considerable value as a foodstuff, and that they might also be utilised as a source of oil. The seeds yield about the same quantity of oil as Neele seeds, and the two oils are very similar in character. Kogai seeds should realise about the same price as Neele seed (see p. 152) if they could be offered in commercial quantities.

At present, there seems no prospect of developing an export trade in the seeds, the production in Sierra Leone being insufficient to meet the local demand. It is understood, however, that enquiries are being made as to the possibilities of cultivating the plant on an extensive scale.

NIGERIA

Samples of *Citrullus vulgaris* seed and oil prepared from it were forwarded to the Imperial Institute in September, 1924, by the District Officer, Hedejia, Kano Province, Nigeria, who furnished the following information. The plant, which is known locally as " Guna," is grown as a catch-crop on the millet farms. At the end of the dry season the fruit is collected and piled in a conical heap on the open farm land. When the rainy season begins, a hole is punched with a pointed stick in each fruit, and the fruits are buried in bulk in a pit and covered with earth. Towards the end of the wet season, the pit is opened and the decayed fruit removed. The seeds are then easily extracted from the decayed shell and are carefully washed. The seeds are to some extent used as food, but owing to the removal of the husk being a laborious process for the native, most of them are used for the extraction of oil, which is obtained by boiling the seeds. In view of the returning prosperity of the ground-nut trade, there is a tendency among the natives to use guna oil for cooking and lighting purposes in place of ground-nut oil, the entire crop of ground-nuts being thus rendered available for sale to the trading companies. Guna oil is not so sweet as ground-nut oil, but is much cheaper, and it seems possible that where it is available it will eventually become a permanent substitute for the latter for domestic use. In view of this fact it was desired to ascertain the commercial value of the seed and oil in Europe, and the quality of the oil in comparison with ground-nut oil.

The seeds received at the Imperial Institute were small, golden yellow, flat, and oval, ⅜ in. long and ¼ in. broad, with a thin papery husk enclosing a cream-coloured oily kernel.

The oil received was slightly cloudy, brown in colour, and liquid, with an unpleasant odour and containing a small amount of deposited "stearins." Traces of moisture and of extraneous impurities were present.

The seeds, as received, were found to contain 6·4 per cent. of moisture, and to yield on extraction with light petroleum 45·0 per cent. of oil, equivalent to a yield of 48·1 per cent. from the moisture-free seeds. The extracted oil was a pale greenish-yellow, limpid liquid, with a slight, pleasant odour. A small amount of "stearins" separated on standing.

The oil extracted at the Imperial Institute and also that prepared in Nigeria were chemically examined after filtration at 100° C. The results are shown in the following table in comparison with the ranges of the corresponding figures recorded for (*a*) ground-nut oil, and (*b*) cotton-seed oil.

	Guna oil.			
	Extracted at Imperial Institute.	Forwarded from Nigeria.	Ground-nut oil.[1]	Cotton-seed oil.[2]
Specific gravity at 15/15° C.	0·9235	0·9234	0·916–0·918	0·922–0·925
Refractive index at 40° C.	1·465	1·465	1·463–1·464	1·465
Solidifying point of fatty acids	—	35·3° C.	27–30° C.	33–38° C.
Acid value	1·6	3·8	1–20	—
Saponification value	192·0	190·1	190–196	192–195
Iodine value (Hübl, 17 hours), *per cent.*	113·1	115·5	87–98	105–115
Unsaponifiable matter, *per cent.*	—	0·9	0·4–0·8	0·8–1·8

[1] *Bolton and Revis "Fatty Foods," p.* 202.

[2] *Loc.. cit, p.* 216.

These results show that Guna oil, like those of other varieties of *C. vulgaris*, belongs to the "semi-drying" class of vegetable oils, whereas ground-nut oil is a "non-drying" oil, as indicated by its lower iodine value. The constants of Guna oil closely resemble those of cotton-seed oil.

As already indicated, the oil prepared in Nigeria had an objectionable odour, owing possibly to the method of preparation employed, and was moreover dark in colour instead of greenish-yellow. A portion of the sample was refined by treatment with caustic soda at the Imperial Institute, and decolourised as far as possible with fuller's earth and charcoal, but the resulting oil, though free from the unpleasant odour, was pale yellowish-brown, whereas the oil extracted from the seeds at the Imperial Institute when refined and decolourised under the same conditions gave a pale straw-yellow product.

The residual meal left after the extraction of oil from the seeds with light petroleum was cream-coloured, odourless and almost tasteless. It was analysed with the following results :

	Guna Meal.	
	As prepared.	Composition of meal containing 7 per cent. of fat.
	Per cent.	*Per cent.*
Moisture	9·2	8·6
Crude proteins . . .	42·6	40·0
Fat	0·9	7·0
Carbohydrates, etc. (by difference)	11·2	10·6
Crude fibre	31·9	29·9
Ash	4·2	3·9
Nutrient ratio . . .	1 : 0·31	1 : 0·67
Food units	120	128

The Guna meal was free from alkaloids and cyanogenetic glucosides.

These Guna seeds would be readily saleable in the United Kingdom as a source of oil and would be worth about £17 to £18 per ton in London (January, 1925) if large consignments of (say) 100 to 200 tons could be offered.

Guna oil of good quality should realise in London the current price of crude Egyptian cotton-seed oil, viz. about £47 per ton (January, 1925). It could be readily refined for edible use, and could be used as a substitute for cotton-seed oil for nearly every purpose. Guna oil would, however, not obtain so high a price as crude ground-nut oil, which is now quoted at £56 per ton in London.

The residual meal is very rich in proteins, and although it contains a high percentage of crude fibre it should be of value as a nitrogenous feeding-stuff for cattle and other animals. It would probably realise in the United Kingdom rather less than extracted soy bean meal, which was recently quoted at £12 to £12 5*s*. per ton in Hull.

TANNING MATERIALS FROM TRAVANCORE

THE barks which were the subject of the investigation recorded in the following pages were received from the Director of Industries, Travancore, in 1924. Two series of barks were forwarded, the first consisting of small samples of eight different kinds, and the second of larger samples of four of these. The following notes regarding the trees yielding the barks are based mainly on information given in Watt's *Dictionary of the Economic Products of India*, and Pearson's *Commercial Guide to the Forest Economic Products of India.*

No. 1. "*Elengi*" (*Mimusops Elengi*, Linn.).—Natural order, Sapotaceæ. A large, highly ornamental, evergreen tree, with fragrant flowers, frequently cultivated in India for its fruit. The bark is used in parts of Bengal, either by itself or in conjunction with that of *Terminalia tomentosa* for dyeing shades of brown, and is also employed as a tanning material in various parts of the country. The oil from the seeds is used for burning in lamps. The timber, which is dark red in colour, extremely hard, and close-grained, is reputed to be one of the strongest of Indian woods, and is used as beams and posts in house-construction and also for cabinet work and other purposes.

No. 2. "*Perzhu*" (*Careya arborea*, Roxb.).—Natural order, Myrtaceæ. A large, rapidly growing deciduous tree found throughout India from the Sub-Himalayan tract to Southern India. The bark is used for tanning in Burma and yields a strong red fibre used locally for cordage. The wood is fairly hard, strong and durable, and is employed in house-building, and for agricultural implements, furniture, gun-stocks, etc.

No. 3. "*Mora*" *or* "*Munga Perzhu*" (*Buchanania latifolia*, Roxb.).—Natural order, Anacardiaceæ. A deciduous tree occurring throughout India, particularly in the hotter and drier parts. The stems yield a gum and the bark is employed locally for tanning. The oily seed-kernels are commonly eaten as a sweetmeat as a substitute for almonds. The wood is used for boxes, bedsteads, doors, window-frames, etc.

No. 4. "*Vaga*" (*Albizzia Lebbek*, Benth.).—Natural order, Leguminosæ. This is a large deciduous tree found wild or cultivated in most parts of India. It is grown (1) in avenues as an ornamental tree, (2) for the sake of its leaves, which are used as fodder, and (3) as a shade tree for tea and coffee. The stems yield an insoluble gum and in some districts the bark is used for tanning fishing nets. The hard and fairly durable wood has a handsome appearance when polished and is used among other purposes for panelling, carving, picture-frames, and turnery. It has been exported from the Andamans, and is known on the English market as East India Walnut. The "burrs" are of great value for veneers.

No. 5. "*Kareencha*" (*Acacia pennata*, Willd.).—Natural order, Leguminosæ. A large, climbing shrub found in the Sub-Himalayan region, Bengal, Burma and Southern India. The bark is an article of internal commerce, being exported from the Konkan, and employed in Bombay for tanning fishing nets.

No. 6. "*Thambagom*" (*Hopea parviflora*, Bedd.).—Natural order, Dipterocarpaceæ. A large handsome tree common in the forests of Southern India. It yields a hard, durable wood, much valued locally for constructional work and ship-building. It has been used with considerable success for railway sleepers in Madras.

No. 7. "*Venga*" (*Pterocarpus Marsupium*, Roxb.).—Natural order, Leguminosæ. A large, deciduous tree of Central and Southern India, extending northwards as far as the Banda District of the North-West Provinces. It yields the drug, gum kino (see p. 163), and the leaves are largely employed as a fodder. The hard, close-grained, durable wood is extensively used in furniture-making, for building purposes, agricultural implements, gun-carriage wheels, etc.

No. 8. "*Thembavu*" (*Terminalia tomentosa*, Bedd.).—Natural order, Combretaceæ. A large deciduous tree common throughout the moister regions of India. The bark is used for dyeing (see above under "Elengi," p. 158), and throughout India as a tanning material. The fruit is also sometimes used for the latter purpose, but is much inferior to ordinary myrobalans (*Terminalia Chebula*). The wood is very hard, of handsome appearance when polished, fairly durable, and equal to teak in strength. It is used throughout India for building, and is also employed for making agricultural implements, and for many other purposes.

The results of examination of the barks at the Imperial Institute were as follows:

SERIES NO. 1

No. 1. "*Elengi*" (*Mimusops Elengi*, Linn.).—Strips of bark, from 9 to 13 in. long and ⅛ to ¼ in. thick. The outer bark was greyish-brown and corky; the inner bark yellowish-brown and fibrous.

The bark was analysed with the following results:

	Per cent.
Moisture	10·7
Insoluble matter	74·3
Extractive matter (non-tannin)	10·5
Tannin	4·5
Ash	2·9

The quantity was too small to permit of tanning trials.

This bark does not contain sufficient tannin to render it of value as a tanning material, except perhaps for local use.

No. 2. "*Perzhu*" (*Careya arborea*, Roxb.).—Strips of bark about 12 in. long and ⅛ to ¼ in. thick. The outer bark was dark brown and corky; the inner bark pale brownish-red and fibrous.

The bark was analysed with the following results:

	Per cent.
Moisture	9·9
Insoluble matter	73·7
Extractive matter (non-tannin)	6·2
Tannin	10·2
Ash	6·0
Tintometer readings:—Red	23·7
Yellow	42·5

The amount of material was too small to permit of tanning trials.

The above analysis shows that this bark is not rich enough in tannin to be profitably exported. The proportion of soluble non-tannin matter is, however, fairly low and the material should therefore be suitable for the preparation of a concentrated tanning extract, but judging from the tintometer readings the leather produced with such extract would be very dark in colour.

No. 3. "*Mora*" *or* "*Munga Perzhu*" (*Buchanania latifolia*, Roxb.).—Strips of bark about 12 in. long and $\frac{5}{16}$ in. thick. The outer bark was dark brown and corky, and characteristically "knobby"; the inner bark was pale pinkish brown and fibrous. The bark showed numerous small resinous exudations.

The bark was analysed with the following results:

	Per cent.
Moisture	8·7
Insoluble matter	68·5
Extractive matter (non-tannin)	9·4
Tannin	13·4
Ash	11·9
Tintometer readings:—Red	16·2
Yellow	30·0

The bark yielded a rather dark reddish-brown, firm leather, of somewhat stiff and harsh texture.

This bark contains too little tannin to be worth exporting, but it might be utilised in the manufacture of tanning extract. The leather produced is, however, dark-coloured and of rather poor quality, and a more satisfactory result could probably be obtained by employing the bark in conjunction with other tanning materials.

No. 4. "*Vaga*" (*Albizzia Lebbek*, Benth.).—Pieces of bark about 12 in. long and ¼ in. thick. The outer bark was brown and corky; the inner bark pale brownish-yellow and fibrous.

The bark was analysed with the following results:

	Per cent.
Moisture	10·4
Insoluble matter	68·5
Extractive matter (non-tannin)	15·8
Tannin	5·3
Ash	4·3

The amount of bark was too small to permit of tanning trials. In any case the sample contains too little tannin to be of commercial value, except possibly for local use, and the high proportion of non-tannin extractive matter renders it unsuitable for extract manufacture.

No. 5. "*Kareencha*" (*Acacia pennata*, Willd.).—Pieces of bark about 12 in. long and ⅛ in. thick. The outer bark was pale greyish-brown, rather thin, and thorny; the inner bark cream-coloured and fibrous.

The bark was analysed with the following results:

	Per cent.
Moisture	10·4
Insoluble matter	77·2
Extractive matter (non-tannin)	9·4
Tannin	3·0
Ash	4·7

The quantity of material available was not sufficient for tanning trials, but it is clear that bark of the above composition would not be worth collecting. A sample of Indian *A. pennata* bark examined by Hooper, however, contained 8·8 per cent. of tannin (*Agricultural Ledger*, 1902, No. 1) and as already mentioned the bark is stated to be an article of commerce, and to be employed in Bombay for tanning fishing nets.

No. 6. "*Thambagom*" (*Hopea parviflora*, Bedd.).—Strips of bark about 12 in. long and ⅛ to ¼ in. thick. The outer bark showed greyish-white to dark brown bands, and was hard and brittle; the inner bark was pale yellowish-brown and fibrous.

The bark was analysed with the following results, which are shown in comparison with figures previously recorded by Pilgrim for samples of young and old *H. parviflora* bark from Madras ("Indian Tanstuffs and their Tannage," *Bulletin*, *No.* 1, 1918, *Esociet Tannin Research Factory*, *Indian Munitions Board*, p. 35).

—	Present sample.		Pilgrim's results.	
	As received.	Moisture-free.	Young bark.	Old bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·8	—	—	—
Insoluble matter	68·2	75·6	78·3	73·6
Extractive matter (non-tannin)	9·7	10·7	4·6	4·7
Tannin	12·3	13·7	17·1	21·7
Ash	2·2	2·4	—	—
Tintometer readings:—Red	3·5	—	11·5	12·0
Yellow	9·4	—	36·0	40·0

The bark produced a buff-coloured, fairly soft, firm leather of good texture and very satisfactory quality.

The amount of tannin present in this bark would not be sufficient to render its export profitable, but in view of the fairly low proportion of soluble non-tannin matter the bark should be suitable for the manufacture of tanning extract. The samples of *H. parviflora* bark examined in India by Pilgrim were richer in tannin, but it will be observed that the tintometer readings were much higher than in the present case, and such barks would therefore yield darker leather than that given by this sample from Travancore.

No. 7. "*Venga*" (*Pterocarpus Marsupium*, Roxb.).—Pieces of bark from 5 to 12 in. long and about ¼ in. thick. The outer bark was brown, rough and corky; the inner bark reddish-brown, fibrous, and covered with dark brownish-red exudations ("kino").

The bark was analysed with the following results:

	Per cent.
Moisture	9·9
Insoluble matter	73·0
Extractive matter (non-tannin)	12·9
Tannin	4·2
Ash	9·6
Tintometer readings:—Red	76·8
Yellow	168·0

These results show that the bark contained too little tannin to render it of commercial interest, except possibly for local use.

The exudation from the bark of *P. Marsupium* is the commercial product known as "Malabar kino," which is used in medicine and is included in the British Pharmacopœia. This "Malabar kino" is stated to contain from 70 to 82 per cent. of tannin, but it is not usually employed as a tanning material, apparently owing to the high prices obtainable for it for medicinal use.

No. 8. "*Thembavu*" (*Terminalia tomentosa*, Bedd.).—Strips of bark about 12 in. long and ⅛ to ¼ in. thick. The outer bark was greyish to dark brown, rough and corky; the inner bark brownish-red and fibrous.

The bark was analysed with the following results:

	Per cent.
Moisture	11·4
Insoluble matter	64·0
Extractive matter (non-tannin)	4·4
Tannin	20·2
Ash	6·7
Tintometer readings:—Red	24·6
Yellow	28·7

The bark furnished a firm, dark leather similar to that yielded by the *Buchanania latifolia* bark (Sample No. 3), though of rather better quality and not quite so harsh. The product was somewhat similar in appearance and quality to mangrove-tanned leather.

Samples of *Terminalia tomentosa* bark from India previously examined at the Imperial Institute contained only from 9 to 17 per cent. of tannin. The bark contains scarcely enough tannin to be worth exporting, but in view of the relatively low percentage of non-tannin extractive matter present, it should be suitable for the manufacture of extract.

On the basis of the present analysis, an extract of the bark containing 20 per cent. of moisture should contain about 65·6 per cent. of tannin and 14·4 per cent. of soluble non-tannins.

Conclusions

The results of this investigation show that none of these eight samples represented bark which could be profitably exported to Europe as a tanning material. The *Terminalia tomentosa* bark (No. 8) contained the highest amount of tannin, viz. about 20 per cent., but it produced a dark-coloured leather which was not of very satisfactory quality.

Although containing too little tannin to be worth exporting, the *Hopea parviflora* bark (No. 6) is a promising material for extract manufacture. Bark of the quality of the present sample should yield a solid extract containing about 50 per cent. of tannin, the minimum desirable in extracts intended for export to the United Kingdom. The samples of *H. parviflora* bark examined by Pilgrim contained appreciably higher amounts of tannin than that found in the present case, and it would therefore be desirable, before attempting the commercial preparation of extract, to ascertain the best conditions for collecting the bark, the influence of the age of the tree on the quality of the material, and the most suitable part of the tree for stripping.

The only other bark which is likely to yield tanning extract of commercial value is *T. tomentosa*, from which it should be possible to prepare a product similar in quality to mangrove extract.

SERIES NO. 2

No. 9. "*Elengi*" (*Mimusops Elengi*, Linn.).—Pieces and quills of bark about 1½ to 4½ in. long, ¼ to 3 in. broad, and 1/16 to ½ in. thick. The outer bark was greyish-brown and corky ; the inner bark reddish-brown and fibrous. A fair amount of powdered bark was present. The sample was generally similar in appearance to the earlier sample of this bark (p. 160).

The bark was analysed with the following results :

	Per cent.	
Moisture	13·1	
Insoluble matter	75·1	
Extractive matter (non-tannin)	8·5	
Tannin	3·3	
Ash	4·1	
Tintometer readings :—Red	70	approx.
Yellow	200	

The bark yielded a dark brown, thin, stiff leather, which showed a tendency to crack.

The results of examination show that this sample of Elengi bark contains even less tannin than the previous sample, and that it would be of little value as a tanning material. The leather produced was, moreover, very dark in colour and of poor quality.

No. 10. "*Pezhu*" (*Careya arborea*, Roxb.).—Strips of bark about 24 in. long, 3 to 5 in. broad, and ½ in. thick. The outer bark was brownish-red and fairly smooth ; the inner bark dark reddish-brown and fibrous. The bark was much thicker than the sample previously examined (see p. 160), and had been freed from the outer corky layer.

The bark was analysed with the following results :

	Per cent.
Moisture	11·3
Insoluble matter	65·6
Extractive matter (non-tannin)	5·1
Tannin	18·0
Ash	5·6
Tintometer readings :—Red	17·3
Yellow	35·5

The bark yielded a plump, firm, rather dark reddish-buff leather, somewhat similar in quality to that produced by wattle bark, but appreciably darker and redder. The tannin in the bark penetrated the hide very slowly.

The results of examination show that this bark is capable of furnishing a firm, moderately soft leather, of very satisfactory quality apart from its colour. The bark contained more tannin than the previous sample, from which it also differed considerably in appearance, but it would not be worth exporting. Bark with so low a proportion of soluble non-tannin matter would, however, be quite suitable for the manufacture of tannin extract, and on the basis of the present analysis a solid extract, with a moisture content of 10 per cent., could be prepared from it, containing about 70 per cent. of tannin and 20 per cent. of soluble non-tannins.

No. 11. "*Vaga*" (*Albizzia Lebbek*, Benth.).—Strips of bark, 23 to 29 in. long, 1¼ to 3¼ in. broad and about $\frac{1}{16}$ in. thick. The outer bark was dark reddish-brown ; the inner bark partly dark brown and partly brownish-yellow. The material, which was somewhat affected by a white mould, was considerably thinner and much less corky than that previously examined (see p. 161).

The bark was analysed with the following results :

	Per cent.	
Moisture	12·7	
Insoluble matter	79·5	
Extractive matter (non-tannin)	5·9	
Tannin	1·9	
Ash	3·7	
Tintometer readings :—Red	43·8	approx.
Yellow	76·9	

The bark yielded a dark reddish-brown leather, fairly plump and firm, but rather harsh.

It will be seen that this further sample of "Vaga" bark contains very little tannin (considerably less even than the earlier sample). Such bark would have no value as a tanning material.

No. 12. *"Kareencha"* (*Acacia pennata*, Willd.).—Strips of bark, 27½ to 30½ in. long, 3½ to 6½ in. broad, and about ¼ in. thick. The outer bark was brownish-red and corky; the inner bark, dark reddish-brown and very fibrous. The sample was somewhat affected by a white mould. It differed from the bark previously examined (see p. 162), in being thicker, more fibrous, much darker in colour, and devoid of thorns.

The bark was analysed with the following results:

	Per cent.
Moisture	14·1
Insoluble matter	71·8
Extractive matter (non-tannin)	4·9
Tannin	9·2
Ash	3·9
Tintometer readings:—Red	13·4
Yellow	24·4

The bark yielded a reddish-brown, fairly plump, rather stiff leather, of somewhat harsh texture. The tannin penetrated the hide very slowly.

Compared with the previous sample of this bark the present material contained somewhat more tannin, the amount now recorded being similar to that found by Hooper in a sample of *A. pennata* bark, as mentioned previously, viz. 8·8 per cent. Bark of the quality of the present sample might be of some value for local tanning, and could be made to furnish a solid extract with a moisture content of 10 per cent., and containing 58·7 per cent. of tannin. This material, however, would not produce a very satisfactory leather.

Conclusions

It will be seen from the foregoing results that with the exception of the "Elengi" bark the materials included in Series No. 2 differed considerably in appearance from the corresponding samples of these barks in Series No. 1. This was especially the case with the "Vaga" and "Kareencha" samples. Both samples of "Elengi," on the other hand, consisted of bark of similar appearance, apparently of about the same age, and contai nilar amounts of tannin. The later samples of zhu" and "Kareencha" barks were very much thicker and older than the earlier samples of these barks, and, as might be expected, contained larger amounts of tannin.

Of the samples in the second series the only one which is at all promising from a commercial point of view is "Pezhu" (*Careya arborea*), which as already indicated would furnish a highly concentrated tannin extract. Extracts made from bark of the quality of the material under report should be able to compete successfully with commercial mangrove extract. Mangrove bark, however, usually contains somewhat more tannin than "Pezhu" bark.

ARTICLES

BANANA CULTIVATION IN THE CANARY ISLANDS

THE writer of the article on "The Banana and its Cultivation with Special Reference to the British Empire" which appeared in this BULLETIN (1924, **22**, 303), has recently visited the Canary Islands, and has now supplied the following additional notes regarding the important banana industry which is carried on in those Islands.

The area of the Canary Islands is estimated at 2,807 sq. miles, but much of this is bare rock, and only a comparatively small part of the land is cultivable, and of this, only certain portions situated along the coast, up to an altitude of about 500 ft. above the sea, are suitable for the banana. The principal areas are at Arucas and Telde in Grand Canary; the north coast of Teneriffe from Orotava to Garachico; at Argual and Tazacorte in La Palma; and in the district of Valle Hermoso in Gomera. Notwithstanding the restricted area under the banana, the cultivation of this crop is by far the most important industry in the islands, and the fruit forms the most valuable of all the exports. Several varieties of the banana have been introduced into the islands, but *Musa Cavendishii*, the Chinese or Canary Islands banana, is the only one of importance.

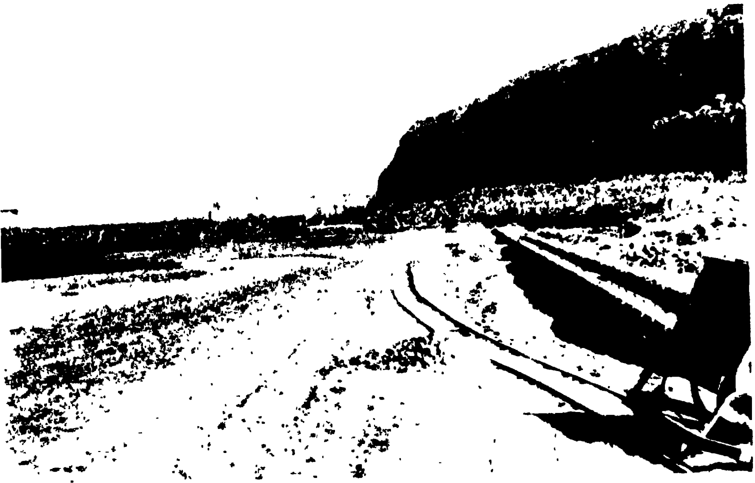

FIG. 1.—RECLAMATION OF LAND AT MALPAIS, SHOWING RETAINING WALL WITH WATER CONDUIT.

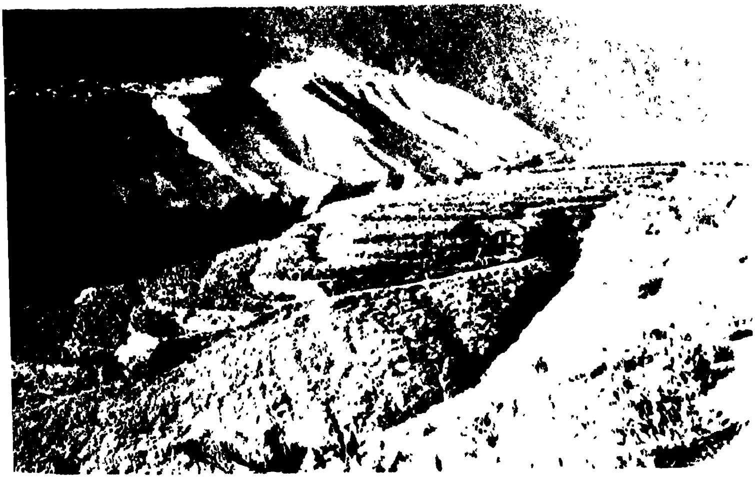

FIG. 2.—BANANAS AT ROMOLINO ON TERRACES IN A RAVINE.

PLATE II

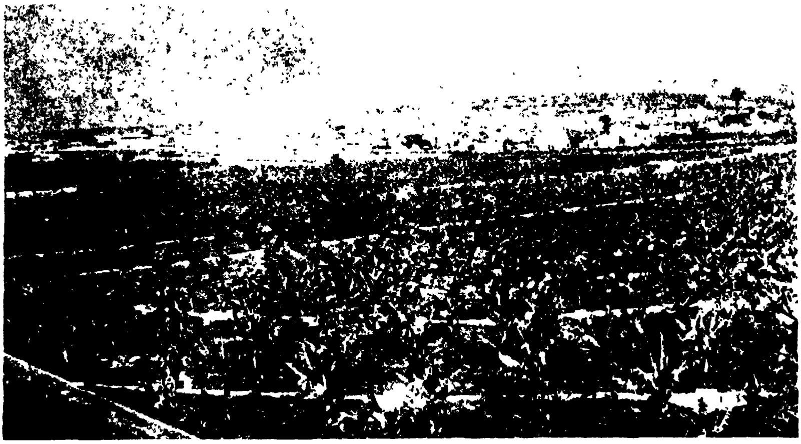

FIG. 1.—BANANA PLANTATIONS AT ARGUAL NEWLY PLANTED WITH OLD STUMPS, SHOWING IRRIGATION CHANNELS.

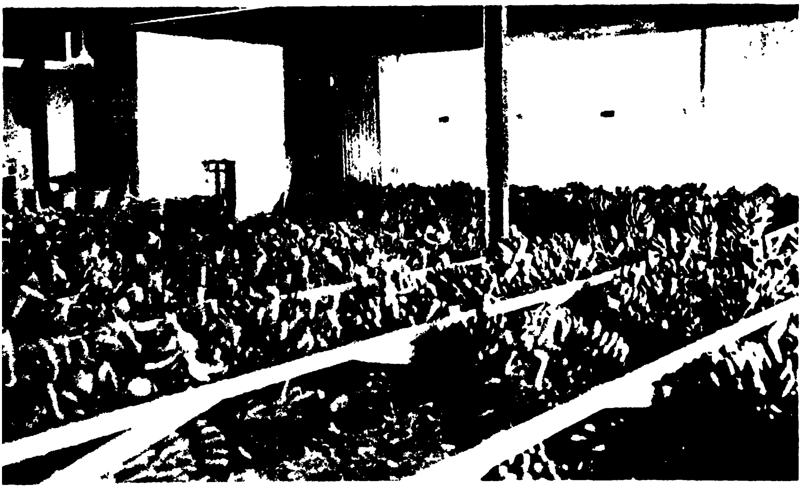

FIG. 2.—MESSRS. FYFFES' PACKING HOUSE AT PUERTO DE SANTA CRUZ, SHOWING GRADED BANANAS.

Much of the land on which the banana is grown has to be made up artificially from soil recovered from " pockets " in the rocks, and is held in terraces on the hill-side by means of walls built of rock. The method of building up such land is well seen in Plate I, fig. 1. These terraces rise one above the other from the coast inland, and often cover the sides of sheltered ravines, as shown in Plate I, fig. 2. The soil on these terraces is usually not more than 4 ft. in depth, and is obtained and transported with much labour. It is in itself poor and, in order to produce continuous yields, it has to be heavily dressed with artificial fertilisers, natural manures being difficult to obtain owing to the lack of vegetation suitable for maintaining domestic animals on a large scale. Given the necessary few feet of soil and a supply of irrigation water, the banana appears to flourish exceedingly without much trouble, and is practically free from any fungal disease. This is probably due to the open nature of the soil and the terraced method of cultivation which afford the perfect drainage so essential to the well-being of the banana plant. There is very little, if any, cultivation of the soil after the bananas are established, the application of water being the chief concern of the planter. The provision of water for irrigation is a great difficulty as, owing to the scanty rainfall, the crop is almost entirely dependent on artificial irrigation (see Plate II, fig. 1). The irrigation water is chiefly obtained by tunnelling into the hill-side. When water is found, it is conveyed to the plantations in open conduits of masonry, built and maintained at considerable cost. Pipes of cement or galvanised iron are now being used to a certain extent for conveying water, and storage tanks of cement are dotted about over the cultivation areas for holding water in case the running supplies give out. The tunnelling for water is done by small private companies formed for that purpose, and, owing to the geological formation of the country and the uncertainties attending tunnelling operations, the business is a very speculative one. In the Department of Overseas Trade Report on the Canary Islands for 1921, H.M. Consul at Tenerife states: " Of the areas now under banana cultivation in the Canary Islands, it is estimated that about 2,000 acres and straw is pushed into the drum round the stalk of the bunch to hold it firmly in position. A circular wooden head is then inserted and, like the base, is fixed by being nailed through the cardboard. The package is now finished and ready for shipping (see Plate III, fig. 2). This is a very expeditious method of packing, and is said to serve very well for short journeys where there is not much handling or exposure to wet, but owing to the absence of packing round the fruit, the drum is the only support and, in the event of the fruit becoming ripe before being unpacked, it is liable to suffer damage by much handling. It is also said that retailers, who are able to sell readily the wooden banana crate, which can be put to many uses, do not look with so much favour on the cardboard drum. The straw packing material used for both crates and drums is imported and dried banana leaves are now seldom used, the latter being found of more value for use as a mulch. The straw used is chiefly oat straw, which is imported in pressed bales from France; whilst the wooden slats of which the crates are constructed are obtained chiefly from Scandinavian countries. These slats, of the requisite sizes, are packed in wired bales, and are built up into crates at the packing sheds; as the parts are standardised, boys and girls can readily put the crates together (see Plate IV, fig. 1). The amount of packing material imported into the Canaries, not only for use in the banana industry, but also for the export of other agricultural produce, such as tomatoes and potatoes, is very large, and is one of the most important items of commerce. The view of a portion of the wharf at Las Palmas shown in Plate IV, fig. 2, indicates to some extent the volume of this trade. An idea of the amount of packing material used in the Islands may be formed from the following figures, which give the amounts actually consumed in the island of Grand Canary only, during the past two years:

	1923. *Tons.*	1924. *Tons.*
Straw	6,700	8,900
Peat	5,050	3,850
Nails	250	280
Wrapping paper	490	520
Binding wire	75	100
Cotton wadding	150	200
Wood	12,900	16,000

PLATE III

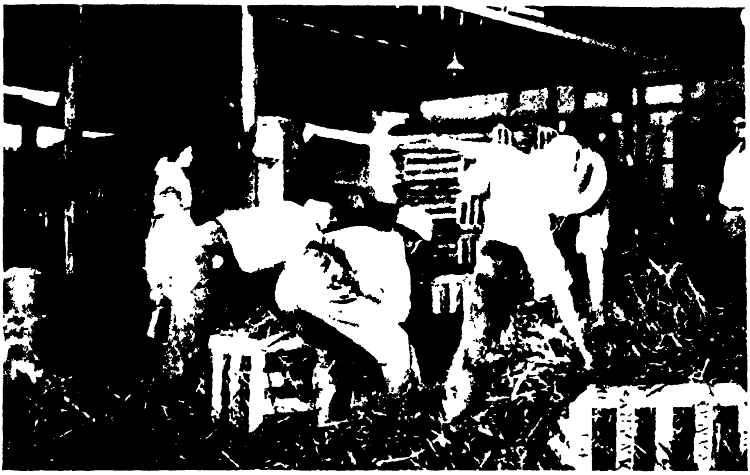

FIG. 1.—PACKING IN OBLONG CRATES—SCENE IN ONE OF MESSRS. FYFFES' PACKING SHEDS.

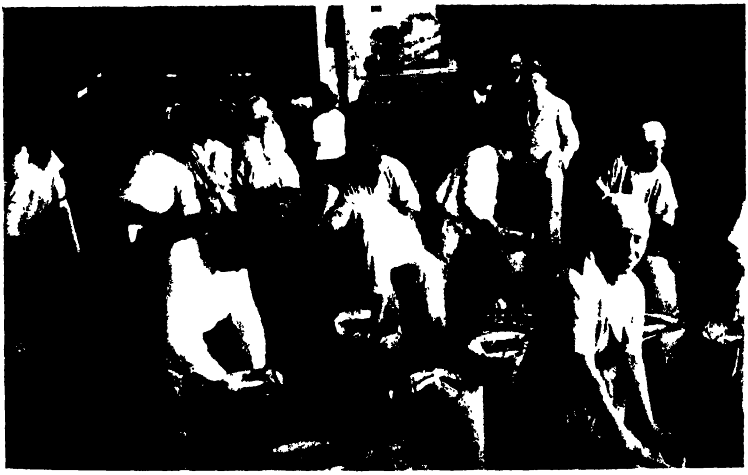

FIG. 2. PACKING IN DRUMS IN ONE OF MESSRS. FYFFES' PACKING SHEDS.

PLATE IV

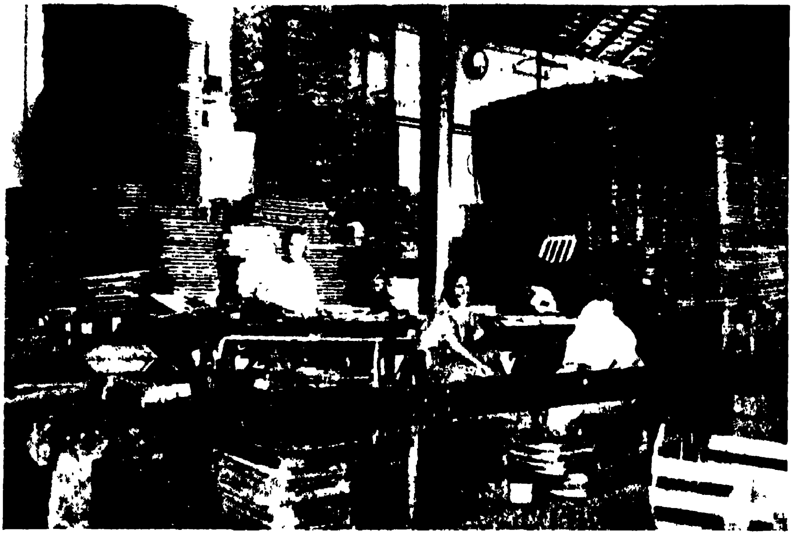

FIG. 1. BUILDING UP CRATES IN ONE OF MESSRS. FYFFES' PACKING SHEDS.

(Stacks of slats in background.)

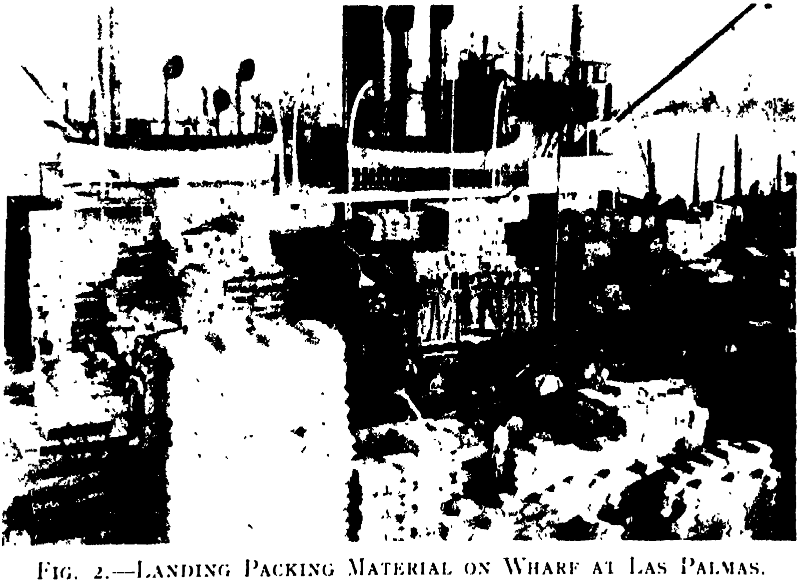

FIG. 2.—LANDING PACKING MATERIAL ON WHARF AT LAS PALMAS.

In considering these figures it should be borne in mind that Grand Canary produces only part of the total output of the Islands ; the exports from this island representing the following percentages of the total :

	1923.	1924.
Bananas	39·4	44·0
Tomatoes	33·4	34·3
Potatoes	41·9	33·0

Straw and wadding are only used in packing bananas ; peat is used only for tomatoes and potatoes.

It would appear worth while for British West African countries or Canada to consider this market for packing materials, at present supplied by foreign countries. Canada, in particular, should find it profitable to enter this trade, since quantities of cereals, dairy produce, tinned goods, building materials, etc., which she could supply, are also imported into the Canaries.

Since the banana industry recovered from the set-back due to the war, the export of fruit has exceeded the pre-war standard, in both quantity and value. According to the Department of Overseas Trade Report already quoted, the quantity of bananas exported in 1913 amounted to 3,488,451 crates, valued at £1,092,953. In 1924 the quantity exported was 3,999,323 crates (30 per cent. containing two bunches each), valued at £1,933,006.

The insect pests that cause trouble are a mealy bug, *Pseudococcus comstockii*, and ants. The ants carry the bug on to clean plants, and if neglected these plants soon become badly infested. The practice of leaving the old leaves as a mulch, although an admirable one for a clean plantation, tends to harbour the mealy bug, and the burning of all old infested leaves would seem to be advisable. In the larger plantations mealy bug is dealt with by spraying with a mixture of creosote, nicotine, petroleum, and soap, and by rubbing the bug off the plants by hand whenever it is met with during the various cultural operations which are constantly going on in the plantations ; a hand spraying machine is used for treating the bunches of fruit. Recently the larvæ of a small moth, *Hieroxestis subcervinella*, have given some trouble by boring into the fruit stalk. The presence of this pest can be detected by the excreted debris which appears at the mouth of the borings, but no effective method, except hand-extraction, appears to have been devised to deal with it.

The illustrations used in this article are from photographs taken by Mr. M. T. Dawe, Commissioner of Lands and Forests, Sierra Leone, to whom the writer is also indebted for the statistics relating to the consumption of packing materials.

Readers desiring further details regarding banana cultivation than are given in the previous article in this BULLETIN should consult the following authorities, to whom the author is indebted for much of the information which was contained therein.

Fawcett, W., *The Banana, Its Cultivation, Distribution, and Commercial Uses*, published under the auspices of the West India Committee, 2nd edition. (London: Duckworth & Co., 1921). (This is the standard work on the subject. See notices in this BULLETIN, 1914, **12**, 166; 1921, **19**, 255).

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Wildeman, É. de., *Les Plantes Tropicales de Grande Culture*, Vol. 1, pp. 307–390. Bruxelles, 1908.

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The Annual Reports and other publications of certain Departments of Agriculture were also utilised by the author in the preparation of the earlier article.

THE PRODUCTION OF ALCOHOL FOR MOTOR FUEL FROM THE NIPA PALM IN NORTH BORNEO

The possibility of utilising the sap of the nipa palm (*Nipa fruticans*) as a source of alcohol was dealt with in an article published in this Bulletin (1922, **20**, 315), and attention was drawn to the work carried out in this direction by the Bureau of Science in the Philippines. The most promising country in the Empire for the establishment of a nipa alcohol industry is the State of North Borneo, and reference was made in the last issue of this Bulletin (1925, **23**, 50) to an experimental plant which had been erected in that country at Kuala Semawang, Labuk Bay.

The following information is taken from a memorandum on nipa motor fuel by Mr. D. D. Wood, Director of Agriculture, North Borneo, based on the results of the first year's working of this plant, which has been furnished to the Imperial Institute by the British North Borneo Company.

It is estimated that in North Borneo there are 300,000 acres of nipa palm occurring in nearly solid stands of 5,000 acres or more. On the basis of an average of 300 flowering plants per acre (after thinning) and an average yield of 10 gallons of sap per year per plant, 900,000,000 gallons of sap could be obtained from the above area. Taking 6·5 per cent. as the amount of alcohol procurable from the sap, it will be seen that the North Borneo nipa areas are capable of producing 58,500,000 gallons of 95–97 per cent. alcohol. The maximum amount of alcohol obtainable from the sap is nearly 8 per cent. by volume, and 7 per cent. should be recovered under practical conditions, but 6·5 per cent. is used in the present case to allow for loss and to form a safe estimate.

The experimental plant erected at Kuala Semawang was rated to produce 100 gallons of motor alcohol in 24 hours, but in actual operation it was found that it was capable of producing twice this amount. The production of alcohol was commenced on January 16, 1924, and continued until June 1, 1924. As far as known this is the first plant ever erected to produce motor fuel from nipa sap, and it is satisfactory to record that it has come up to expectations in every way.

It was not expected that an amount at all approaching the maximum could be produced during the first year for the following reasons. (1) The nipa palms were a virgin stand, and consequently the flower stalks were scattered over a larger area than would be the case in an old cultivated area. (2) The industry was new to nearly all concerned and many fruit stalks were not properly treated before tapping. A few tappers knew the work, but it was impossible for them to get all the other tappers to observe their instructions. Even with poor treatment the palms gave an average yield of between 6 and 7 gallons of sap. There are now men, however, who know the work and realise the importance of treating the fruit stalk before tapping. (3) In order to attract labour it was necessary to pay by the month. The workers would not contract at a definite payment per gallon as there was no certainty as to the quantity they could collect. Towards the end of the season, however, payment was made by results and during the 1925 season all the sap will be collected on contract. (4) At first there was a certain amount of loss in distilling as none of the workers were familiar with this operation, but this was soon rectified. (5) Pests did an enormous amount of damage after tapping had started, monkeys eating the young flowers, and pigs the stems. Poison was used effectively, but not until most of the damage had been done.

As a consequence of the above-mentioned difficulties the actual cost of producing fuel was extremely high. At the time of reporting there were 1,000 gallons on hand, comprising the entire output for the 1924 season. The actual cost of production was $3·62 (8*s*. 5*d*.) per gallon, exclusive of depreciation, insurance and interest, which brought the total up to $9·87 (23*s*.) per gallon.

Mr. Wood gives in detail the estimated cost of producing alcohol at the experimental plant in the 1925 season, based on a working period of 180 days, i.e. the period of sap flow. The following table, extracted from the estimate, shows the total cost of collecting, distilling, etc. The figures under the heading A are the cost of running the still 12 hours per day with the production of 100 gallons, giving a total of 18,000 gallons of alcohol; those under B are for a 24-hours' day, producing 200 gallons, or a total of 36,000 gallons.

—	A		B	
	Per Year.	*Per. Gal.*	*Per Year.*	*Per Gal.*
	$	$	$	$
Total collecting costs. . .	3,300	0·18332	6,600	0·18332
Total distilling costs . . .	4,620	0·25664	7,020	0·19496
Total other costs (depreciation, insurance, interest, royalty, etc.)	7,450	0·41388	8,170	0·22694
Total cost	15,370	0·85384	21,790	0·60522

The number of tappers required for running the still for 12 hours per day is estimated at 10 for two months (to prepare the fruit stalks for tapping) and 20 for six months. Each of the latter, it is assumed, could collect 80 gallons of sap per day, which is regarded as a low estimate. In running the plant for 24 hours per day, twice the number would of course be required. When definite areas of nipa swamp are given out to families, the cost of preparing the fruit stalks for tapping would not appear in the estimates, as this would have to be done by the families concerned.

The distilling costs of a small plant are naturally very high and can only be sufficiently lowered if the plant is run for 24 hours per day. The cost of the chemicals used for denaturing could also be reduced by buying large quantities at a time.

In estimating the other costs Mr. Wood has allowed a rather high figure for depreciation of the temporary plant. A large commercial plant, however, would be permanent and the buildings more substantial, so that the loss from depreciation would in such cases be much lower.

Although the estimated cost at Semawang appears high, ranging from 60 to 85 cents per gallon, according to the number of hours the still is run, the figures are regarded as very encouraging, considering the experimental nature of the plant. Mr. Wood believes that if a permanent plant were erected to produce not less than 1,000 gallons per day it would prove a commercial success. The overhead charges of such a plant would be very much lower than those of the small plant on which the figures are based.

Mr. Wood also gives in detail estimated costs of production for plants of three different capacities when running both for 12 and for 24 hours per day. These estimates are summarised in the table opposite.

The cost of collecting included in these estimates is based on the figures used for the small area, and the remarks made on page 177 regarding the possibility of reducing the cost apply equally in the case of the larger areas now dealt with. It may be possible, also, when working on a commercial scale, to lower the cost of collecting the sap by installing collecting tanks in the swamps and pumping the sap to the distillery.

It will be seen that the distilling costs are gradually reduced, according to the size of the plant and the hours of working, from 11 cents per gallon in a 2,000 gallon plant running 12 hours to 7 cents per gallon in an 8,000 gallon plant running 24 hours. If it were found practicable to deliver the sap to a central point by pumping, the size of the distillery would be limited only by the quantity of sap available in the area. It would not be advisable, however, to erect in any one place a plant capable of producing more than 8,000 gallons, as this would require an area of about 7,000 acres of nipa swamp to supply it, and the cost of delivering the sap to the distillery from a larger area than this would probably be too high under present conditions of collection.

The following areas are necessary to produce the amounts of 95–97 per cent. alcohol mentioned :

Quantity per day. *Gals.*	Area. *Acres.*
100	90
200	180
1,000	900
2,000	1,800
4,000	3,600
8,000	7,200
10,000	9,000

	2,000 gallon plant.				4,000 gallon plant.				8,000 gallon plant.			
	12 hrs. per day.		24 hrs. per day.		12 hrs. per day.		24 hrs. per day.		12 hrs. per day.		24 hrs. per day.	
	Per year.	*Per gal.*	*Per year.*	*Per gal.*	*Per year.*	*Per gal.*	*Per year.*	*Per gal.*	*Per year.*	*Per gal.*	*Per year.*	*Per gal.*
	$	$	$	$	$	$	$	$	$	$	$	$
Total collecting costs .	33,000	0·18332	66,000	0·18332	66,000	0·18332	132,000	0·18332	132,000	0·18332	264,000	0·18332
Total distilling costs .	19,185	0·10656	31,170	0·08655	30,210	0·08389	61,620	0·08577	60,960	0·08464[1]	103,320	0·07175
Total other costs (depreciation, insurance, royalty, cost of running launch, etc.) . .	24,600	0·13664	31,800	0·08830	42,000	0·11663	57,600	0·07997	78,000	0·10830	106,800	0·07414
Total producing costs .	76,785	0·4266	128,970	0·3582	138,210	0·3838	251,220	0·3491	270,960	0·3763	474,120	0·3292
Total capital required .	$220,000		$272,000		$423,000		$537,000		$841,000		$1,044,000	

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[1] *The increase in this case as compared with a 4,000 gallon plant is due to the fact that the estimate allows for a superintendent.*

The cost of thinning the nipa will not exceed $10 per acre, which was the contract price at Semawang.

Taking for granted that the alcohol can be produced and put on board ship at Sandakan for the figures given in the estimate, delivered in Singapore or Hong Kong for an additional 10 cents per gallon, and sold to distributing stations for 65 cents per gallon, this gives a net profit of 12 cents and 19 cents per gallon for the 2,000 gallon plant; 16 cents and 20 cents per gallon for the 4,000 gallon plant; and 17 cents and 22 cents per gallon for the 8,000 gallon plant. This is equivalent to dividends of $21,500 on $220,000 capital (or 10 per cent.), and $68,400 on $272,000 capital (or 25 per cent.), $57,600 on $423,000 capital (or 13 per cent.), and $144,000 on $537,000 capital (or 26 per cent.); $122,400 on $841,000 capital (or 14 per cent.), and $316,800 on $1,044,000 capital (or 30 per cent.).

The above figures are for plants of the three different sizes, running 12 hours and 24 hours respectively. It is apparent that a plant of this kind should be run for the 24-hour period if possible as this would cut down the overhead expenses of distilling and other costs enormously. It must be remembered that the flow of sap is only for six months, and every advantage must be taken of this, as most of the overhead expenses will continue while the plant is idle. All costs are for the whole year, except for tappers who are paid by results; if some other work could be found for these men for about four months in each year the costs would be still further reduced.

Mr. Wood is convinced that the local natives cannot be depended on, and it will be necessary to use Chinese labour. The work of collecting the sap is not hard and would be suitable for Chinese, and as far as possible whole families should be settled on or near the area assigned to them. When tapping is started it must be continued until the end of the season. Mr. Wood believes that a Chinaman would be able to collect nearly double the amount he has estimated for one native. Labour is a very important item, and unless the right type of labour is brought in, the project will be a dismal failure. Chinese are not averse from living in out-of-the-way places, and

Mr. Wood mentions that he has seen them in the Federated Malay States with their houses built in mangrove swamps where they were cutting firewood. Chinese are frugal and are not inclined to stop work when they have laid aside a few dollars. Just the opposite is true of the native labour.

The labourers employed in the nipa swamps have enjoyed excellent health and no sickness has occurred that could be attributed to their work. Malaria has not appeared and the only necessity for the dresser was in case of accident to any of the labourers.

The fuel, when completed for use in internal combustion engines, is a mixture of ethyl alcohol (66 per cent.), ether (33 per cent.), and either pyridine or aniline oil (1 per cent.). This mixture has been found to be very efficient, and if the carburetter is properly adjusted the same mileage is obtained as with petrol. The great advantage of this mixture is the fact that it does not depend on any form of petroleum as do many other fuel mixtures. The aniline or pyridine acts both as a denaturant and as a neutraliser of any acids formed during combustion. The ether is made direct from the alcohol by the usual process. The denaturant is the only substance that must be imported for the mixture.

The fuel when compared with petrol has no disadvantages, but several advantages, of which the greatest are the following: the engine never overheats, there is practically no carbon deposit, and sparking plugs never foul; knocking of engine is eliminated; consumption of lubricating oil is reduced in some cases by as much as 50 per cent.; on account of the ether the engine starts easily from the cold; and if the fuel catches fire it can be extinguished with water.

CADMIUM: ITS OCCURRENCE, USES AND PRODUCTION

GENERAL

CADMIUM was discovered by F. Strohmeyer in 1817 in a sample of zinc carbonate. About the same time, Hermann, a German chemical manufacturer, discovered the new element in a specimen of zinc oxide, and named it cadmium. Later, independent discoveries of the metal were made by Meissner of Halle and Karsten of Berlin.

Cadmium, although widely distributed in nature, is not an abundant element. *Greenockite* (CdS) or cadmium-blende is the only cadmium mineral of any importance. It usually occurs as a coating on blende and other zinc minerals, but has never been found in sufficient quantity to be mined. It crystallises in the hexagonal system; is brittle; has a hardness of 3–3·5; specific gravity of 4·9–5·0; and a lustre varying from adamantine to resinous. The colour of the mineral ranges from honey-citron or orange-yellow to bronze-yellow.

Otavite is a basic carbonate, containing 61·5 per cent. of cadmium.

Przibramite is a reddish cadmiferous blende containing up to 5 per cent. of cadmium.

The chief source of cadmium is cadmiferous zinc ore—blende, smithsonite or calamine. Cadmium is present in blende and wurtzite as isomorphous greenockite. In calamine it is present as carbonate (otavite). Certain lead and copper ores also contain cadmium, but this is solely due to the presence in them of zinc compounds or minerals.

Cadmium has been detected in the mine waters of the Joplin zinc district, Missouri. It is also sometimes present in coal seams. Richardson reported the occurrence of 1·42 per cent. of cadmium in the ash of coal from Berwick County, Scotland. According to E. Jensch it is present in the coal seams of Upper Silesia, probably in the pyrite; unwashed coal from this source gave 0·008 per cent. of cadmium.

PROPERTIES OF CADMIUM

Cadmium is closely related to zinc, both physically and chemically. It is a metal of a tin-white colour and metallic lustre, and takes a high polish. It crystallises in hexagonal pyramids. The following are some of its most important physical properties: specific gravity, 8·6040 (cast), 8·6944 (hammered); specific heat, 0·057; melting point, 320° C.; boiling point, 765·9° C.; thermal conductivity (silver = 100), 20·06; electrical conductivity (mercury at 0° C. = 1), 13·95; coefficient of linear expansion, 0·0000306; tensile strength, 13,660 lb. per sq. in.; elongation, 44 per cent. in 3 in. Cadmium is ductile and malleable at ordinary temperatures; at 80° C. it becomes brittle and is easily pulverised.

The atomic weight is 112·4; the atomic volume, 12·9. Cadmium is not attacked by dry air, but is oxidised superficially by damp air. At a red heat the metal burns to the yellowish-brown cadmium oxide (CdO). Cadmium is slowly dissolved by sulphuric and hydrochloric acids, and readily by nitric acid, forming normal salts, most of which are freely soluble in water. Cadmium being less electro-positive than zinc, is precipitated from its solutions by that metal.

METALLURGY

Metallic cadmium is produced from: (1) flue dust from the roasting of cadmium-containing zinc ores, or from brass works; (2) the "blue powder" (zinc dust) collected in the early stage of retorting such ores; (3) bag-house fume from lead and copper blast furnaces; (4) residues from the purification tanks of electrolytic refineries, and from lithopone, zinc sulphate and zinc chloride plants.

The volatility of cadmium being greater than that of zinc, it tends to concentrate in the material deposited in the furnace flues. On fractional distillation, the resulting product contains a high percentage of cadmium, sufficient to permit of its being refined.

The standard bag-house (filtration plant) is a large room in which several hundred tubes of cotton or other cloth from 30 to 50 ft. long and from 18 to 20 in. in diameter (the "bags") are suspended. In lead and copper blast-furnaces the dust may be accumulated for years before the quantity is sufficient to be worth treatment. Assays of more or less concentrated dust from lead blast furnaces contained at Leadville, 5·5; at Pueblo, 5·1 to 7; at Durango, 1·4; at Murry, 5·05; and at Midvale, 0·02 per cent. of cadmium.

For extracting cadmium metal from the above materials both dry and wet methods are now in use.

Dry Methods.—In Silesia, the first portion of the distillate from the zinc retorts consists of "blue powder" or a mixture of zinc and cadmium oxide, often containing from 6 to 8 per cent. of cadmium. In the old Silesian process, this is mixed with 50 per cent. of its weight of carbon and distilled in a retort at a dull-red heat for twenty-two hours. The dust is collected in a conical sheet-iron prolong or condenser. The concentrated material contains 75 per cent. of cadmium. The residue in the retort contains from 40 to 50 per cent. of zinc and goes to the zinc-distilling furnace. The concentrated material is mixed with 40 per cent. of charcoal or 60 per cent. of high-grade coke, moistened, and charged into a cast-iron retort, provided, as soon as the distillation begins, with a sheet-iron condenser. The distillation, which takes place at a dull-red temperature, lasts twenty-four hours. Cadmium collects in front of the retort, and is removed every four hours with an iron ladle. Any metal that may be collected in the condenser is returned, from time to time, to the retort. The crude cadmium is melted in a cast-iron kettle under a cover of oil, and cast into sticks, pencils or rods, $\frac{5}{16}$ in. in diameter and 12 in. long.

In modern Silesian practice, the fume containing from 3 to 4 per cent. of cadmium, is mixed with 15 per cent. of fine coke and charged into a retort or muffle provided with a sheet-iron condenser. The temperature is kept at a dark-red glow (800° C.). The distillation lasts twenty-two hours. The reduced cadmium is collected in the condensers, partly as metal, partly as oxide. The powder is collected and distilled every third day in a smaller muffle, a higher temperature than in the larger muffle being maintained. The metal collected in the condenser is 99·5 per cent. pure, and together with that from the larger condenser is re-melted under tallow and cast into sticks. Much cadmium is lost in the distillation process. The yield is stated to be about 30 per cent., 49 per cent. being lost by volatilisation, and about 21 per cent. remaining in the residue. According to Bugden the total yield is under 10 per cent. of the quantity originally contained in the ore.

The distillation process was the only one used in Silesia until 1906.

Wet Methods appear to be best adapted for treating flue dust or bag-house fume. They consist of (1) chemical precipitation from solution, and (2) electrolytical precipitation from solution.

(1) In this method, as used at Denver, Colorado, the material is mixed with sulphuric acid of 60° Bé., and sufficient water is added to form a paste or mud. The mud is heated to 230° C. for four days in a flue, when it forms a cake. This is crushed to ¼-in. size and heated to 325° C. from forty-eight to sixty hours in an iron pan. The resulting disintegrated powder is gradually dissolved in water heated to 65° C. The clear solution, containing about 34 per cent. of cadmium sulphate, is siphoned into purification vats, 10 lb. of copper sulphate is added for each pound of arsenic present, and the solution is heated nearly to boiling point. Some scrap iron and a little sulphuric acid are added. The arsenic is precipitated as a compound of arsenic and copper, and the excess of copper is removed by the scrap iron. The liquor is then heated for four or five days in a lead-lined wooden tank of about 250 gals. capacity, containing suspended slabs of spelter. The resulting spongy metallic cadmium is compressed into cylinders 6 in. in diameter, each weighing about 130 lb. These are cut into pieces 3 in. thick which are distilled in graphite retorts, the condensed metal (65 per cent. cadmium) being finally melted in a kettle and cast into sticks.

(2) The method practised at Kennett, California, has been described by H. R. Hanley. The cadmium is first deposited as a sponge by means of metallic zinc. This is washed, drained, and dissolved in spent acid electrolyte at a temperature of 50° or 60° C. When the solution contains from 90 to 100 grammes of cadmium per litre, it is neutralised with lime to free it from iron. The solution is then re-acidified and transferred to cells having slowly revolving aluminium cathodes. The deposition of cadmium is 113 lb. per cell in twenty-four hours, which represents 80 per cent. efficiency with a current of 15 ampères per sq. ft. of cathode at 4 volts. Each pound of cadmium deposited requires 1·27 k.w. hours. The cathodes are melted in a bath of heavy oil, cast into bars;

and the bars into sticks under a cover of molten caustic soda.

The following are percentage analyses of cadmium metal from three United States producers :

	1.	2.	3.
Cadmium	99·839	99·610	99·750
Copper	0·005	0·050	—
Lead	0·040	0·320	0·030
Arsenic	0·009	—	—
Zinc	0·100	0·010	0·180
Iron	—	0·005	—

Electrolytic methods are employed for the refining of cadmium, the latter being deposited on the platinum electrode and distilled *in vacuo.*

USES

The most important present use of cadmium is as a constituent of alloys with exceptionally low melting points. Such alloys are mixtures of cadmium, lead, tin and bismuth in different proportions (*see* Imperial Institute Monograph, *Bismuth Ores*, 1925, pp. 17, 18).

Cliché metal for stereotype plates has the following percentage composition : lead, 50 ; tin, 27·5 ; cadmium, 22·5. It is said to be superior to the corresponding alloy of bismuth. A similar alloy is used in the manufacture of flexible plugs in automatic fire-extinguishers and safety-plugs in boilers. An alloy used in the manufacture of fuse wire for electric installation has the following composition : bismuth, 50 ; tin, 21 ; lead, 20 ; and cadmium, 15 parts by weight.

Copper wire containing small percentages of cadmium is used for electrical transmission. Compared with pure copper wire it has an increased annealing temperature, greater hardness and a much greater tensile strength—1·1 per cent. of cadmium raising the last from 63,000 to 100,000 lb. per sq. in. The electrical conductivity of such an alloy is 89 per cent. of that of pure copper. An alloy of copper with 0·5 to 1·2 per cent. of cadmium has been used with success for wireless aerials, long span transmission wire and wire for overhead trolley use. Of all applications of cadmium in the future, this will probably be the most important.

Cadmium-silver alloys containing over 89 per cent. of silver are uniform and well suited as material for trial plates for silver coinage and ware, for which the silver-copper alloy is not quite satisfactory. Alloys containing gold and silver, and from 8·4 to 12·5 per cent. of cadmium, are green in colour and have a certain vogue in the jewellery trade. Sometimes copper is used to replace a portion of the cadmium in these alloys.

Patented alloys of lead and cadmium have been proposed as bearing metals. A tabulated list of these alloys, which are said to be hard and fine-grained, is given by Urquhart.

Cadmium is also used to replace tin, partly or entirely, in solders. As a result of a series of investigations conducted at Risdon, Tasmania, solders have been developed in which a considerable proportion of the tin of ordinary solders has been replaced by cadmium without any appreciable diminution in the applicability or general utility of the solder.

An amalgam of cadmium was formerly used in dentistry, but its use has been discontinued, as it produces discolouration of the dentine.

Alloys of zinc and cadmium are very brittle. The effect of the metal on spelter may be serious. Cadmium has a pronounced hardening effect on spelter and tends to increase its brittleness; 0·25 per cent. of cadmium makes zinc difficult to roll; and 0·5 per cent. makes it almost unrollable. George C. Stone states that hollow ("slush") castings cannot be made successfully from cadmium-bearing spelter, even if the percentage be as low as 0·05. He also states that in galvanising telegraph and telephone wire, the spelter employed should be free from cadmium; that it is injurious in manganese bronze, and, if present in large quantities, causes weakness in brass and increases the liability of cracking. An examination of brass containing from 1 to 3 per cent. of cadmium plainly shows a concentration of an alloy rich in zinc and cadmium along the boundaries of the brass crystals. Very small quantities of cadmium in aluminium-zinc alloys lead to disintegration from corrosion, under conditions that leave a pure alloy unaffected. It is probable that it has a similar effect on copper-zinc alloys.

According to Bugden cadmium is rarely present in commercial spelter in injurious proportions, the usual quantity being under 0·2 per cent.; moreover the electrolytic process of zinc extraction affords an easy means for the separation of the cadmium.

In the United States Navy Grade "A" spelter the maximum impurities allowed are cadmium, 0·05; iron, 0·03; lead, 0·07; or total lead, iron and cadmium, 0·10 per cent. In the United States Army Grade spelter the maximum impurities allowed are: cadmium, 0·50; iron, 0·03; lead, 0·10; or total lead, iron and cadmium, 0·50 per cent.

Alloys containing cadmium are used for the manufacture of hair-springs for watches and clocks. They have many of the attributes of steel, but do not rust, and are non-magnetic. The following is the range of percentage composition of one class of alloy used: platinum, 52·25–67·75; copper, 16·88–18·00; nickel, 18·00–18·25; cadmium, 1·25; cobalt, 2·00; tungsten, 1·87. Another class of alloy consists of: aluminium, 90·00–96·50; nickel, 0·50–1·00; antimony, 0·50–5·00; cadmium, 2·50–4·00 per cent.

Cadmium is also used with the cerium earth metals for the production of pyrophoric[1] alloys which contain from 30 to 40 per cent. of zinc.

Cadmium is used as a deoxidiser in making bronze telegraph and telephone wires and cables in France and Italy, and for the same purpose is added to molten aluminium, silver and nickel alloys before casting.

During the Great War cadmium was largely used by the Germans as a substitute for tin in solders, etc., and is also said to have been used in smoke bombs for signalling, and in making small-arms ammunition.

Since 1895 alloys of cadmium with a little silver have been used instead of nickel for electroplating metal parts exposed to corrosion. Up to 25 per cent. of cadmium may be used without affecting the colour or appearance of the plate.

The Udylite process of electroplating with cadmium consists of depositing a coating of cadmium, 0·0001 to 0·01 in. in thickness, on iron and steel, and baking the coated article at a temperature of 150° to 200° C. for several hours, by which a thin skin of cadmium-iron alloy is formed with a cadmium outer surface. The metal so treated can be flexed and twisted to the breaking point, without showing evidence of any plating of the coating. In practice, graphite or steel anodes are used, the cadmium compounds used for forming the electrolyte being cadmium oxide and cadmium hydroxide. This process was first developed as a means of preventing the corrosion of piano wires and springs. In America its use appears to be extending. In 1922 more than fifty plants were in operation, and new installations were proceeding at the rate of six or eight a month. The process has been applied with success to general hardware, locks, automobile parts, etc.

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[1] Spark-emitting alloys such as are used in automatic lighters.

Cadmium is also sometimes used in the Schoop spraying process in which the protective coating is applied in molten form.

Cadmium pigment consists of cadmium sulphide, *cadmium-yellow* or *jaune brillant*, the colour being persistent and unaffected by the action of hydrogen sulphide. According to Buchner, two modifications of the pigment exist: the α variety, precipitated by hydrogen sulphide in faintly acid solutions, which is lemon-yellow and possesses good covering power; and the β variety, produced from strongly acid solutions, which resembles red lead, possesses good covering power, and is ordinarily quite permanent; if heated it changes to the α variety, and various shades are obtainable by mixing them. In the United States cadmium-yellow is employed as a protective coating over chrome-yellow in painting street cars and passenger coaches on certain railways. Cadmium sulphide is used as a pigment for high-class rubber goods, and for tinting toilet soaps. It is also used in calico-printing, for colouring glass and porcelain, and as artists' colours—e.g. cadmium sulphide is mixed with zinc oxide or heavy spar (barytes) to furnish an imitation Naples yellow, and with ultramarine to prepare a green pigment.

Cadmium lithopone is a mixture of cadmium sulphide and barium sulphate, the former replacing zinc sulphide in standard lithopone. An admixture of only 5 per cent.

of cadmium lithopone gives a pleasing and distinct cream-yellow when rubbed out in oil.

The following chemical compounds of cadmium have been used in the industries: the chloride ($CdCl_2$), for testing pyridine bases in calico-printing and dye works, also in photography and in medicine; the iodide (CdI_2), in medicine and for iodising collodion plates in photography; the hydrated bromide in photography and in medicine; the sulphide in pyrotechnics; the tungstate as a paint for fluorescent screens in radioscopy; the salicylate as an external antiseptic; the sulphate as an electrolyte in the Weston cell, which is a standard of E.M.F., and also in medicine for affections of the eye; and the acetate in dentistry.

Cadmium alloyed with a very small quantity of gallium is used in a vapour arc lamp, as a source of an intense monochromatic red light useful in physical investigations.

Cadmium gives a brilliant spectrum of red, green and blue lines, and its use has been suggested as a convenient standard in refractometry.

DISTRIBUTION

Zinc ores containing small percentages of cadmium are fairly generally distributed, as will be seen from the following paragraphs:

Great Britain.—Zinc ores mined in the Matlock district of Derbyshire and at Wanlockhead in Dumfriesshire are said to have contained 0·4 per cent. of cadmium. Clark found cadmium in the calamine of Derbyshire, and in the smithsonite of Mendip, Somerset, and of Derbyshire and Cumberland. According to Dana, greenockite occurs in short hexagonal crystals at Bishoptown in Renfrewshire, Scotland, in a porphyritic trap and amygdaloid, associated with prehnite; also at Bowling, near Old Kilpatrick, and at the Boylestone quarry, Barrhead, near Glasgow.

Australia.—The blende of the Broken Hill main lode, New South Wales, is of the dark-brown variety containing a considerable percentage of iron with traces of other metals, such as cobalt, nickel and cadmium.

At Risdon, Tasmania, cadmium is present in the

Broken Hill zinc concentrates treated there to the amount of 0·03 per cent. During the purification of the zinc solutions a product is incidentally obtained containing 10 per cent. of cadmium, which is separately worked up for the production of the metal. In 1923, the Risdon works produced 41,158 tons of electrolytic zinc and 107 tons of cadmium, the value of the latter being £27,551.

Greenockite is associated with blende in the Ravenswood Goldfield, Queensland, and cadmium has been detected in minute quantities in blende in the same locality and in several of the mines in the Burketown Mineral Field.

Cadmium is present in appreciable quantities in the blendes of Northampton, Western Australia ; and probably exists in recognisable amounts in other zinc ores in the State.

Austria.—At Freistritz, on the Drau, Austria, one mine yielded blende, containing 0·65 per cent., and carbonate ore, containing 0·14 per cent. of cadmium. Blende from Sterzing, Tyrol, and Stollersbochthal, Salzburg, gave over 0·2 and zinc ores from Styria and Carinthia gave 0·008 to 0·140 per cent. of cadmium.

Belgium.—The blendes of Belgium contain 0·13 to 0·21 per cent. of cadmium.

Finland.—According to Jensch a black blende from Finland contained 0·46 per cent. of cadmium.

Germany.—The zinc ore from the Hecklen mine in the Erzgebirge delivered to smelting works in Upper Silesia during the period 1889–1900, contained an average of 0·1 per cent. of cadmium, but other zinc ores mined in the same region contained smaller proportions of the metal. At Brilon, Westphalia, in Breisgau, Baden, and at Bleiberg, near Aachen, Rhine Province, zinc ore has been mined which was relatively high in cadmium, in one case containing as much as 0·39 per cent.

According to Klieeisen, the blendes of the Upper Harz contain at most 0·01 per cent. of cadmium. Blende from the Hercules mine, Schwarzenberg, Saxony, gave 0·1 ; from Fürstenbrunn, Schwarzenberg, 0·065 ; from Carolinenthal, near the same place, 0·011 ; from Brestenbrun, Johann-Georgenstadt, 0·02 ; from Ücherath, in

Rheinland, 0·39; and radiating blende from Przibram, Bohemia, 1·136 per cent. of cadmium.

Italy.—Rimatori found up to 1·66 per cent. of cadmium in fifteen samples of blende from Sardinia. Zinc ores from Carniola yield from 0·008 to 0·140 per cent.

Rumania.—Blende mined at Kapnik Banya, and at Offenbanya, in Transylvania, contains over 0·3 per cent. of cadmium. A zinc ore at Kirklaba, in Southern Bukovina, gave 0·27 per cent.

Spain.—In the Province of Santander, Spain, blende ores are found which contain from 0·03 to 0·4 per cent. of cadmium. Blende from the Cantabrian coast (Oviedo and Lugo) gave over 0·4, and Spanish smithsonites from 2 to 5 per cent.

Sweden.—Zinc ores mined in Sweden and sent to Upper Silesia for smelting were found to be relatively rich in cadmium, the percentage ranging from 0·17 to 0·36.

Upper Silesia.—E. Jensch gives a number of analyses of cadmium occurring in zinc ores mined in Upper Silesia, on the border between Poland and Germany, from which the following, from the Beuthem district, are taken:

Name of Mine.	Cadmium Content. *Per cent.*	Remarks.
Samuelsglücke	0·095	Average of 5 analyses
Neu Viktoria	0·230	Highest of 11 analyses
Aufschluss	0·153	One analysis
Kramersglücke	0·306	One analysis
Birkenhaim	0·123	Average of two analyses

United States.—Cadmium has been produced in the United States since 1907 by the Grasselli Chemical Co. of Cleveland, Ohio. In 1919 there were six operating plants, including that of the Grasselli Co., and from early in 1923 the electrolytic zinc plant of the Anaconda Copper Mining Co., at Great Falls, Montana, has produced cadmium as a by-product.

According to Siebenthal, in the Eastern States, blende from Eaton, New Hampshire, and from Friedensville, Pennsylvania, has been proved to be cadmium-bearing. The ores of the Upper Mississippi Valley are comparatively free from cadmium. The zinc ore of the Kentucky-Illinois fluorspar district contains a considerable quantity of cadmium, and secondary deposition of greenockite has been noted as common. Greenockite in this district occurs in greenish-yellow or orange-yellow films coating the walls of cracks in ore and rocks near, and usually above, the ground-water level. These films, where of appreciable thickness, very much resemble the precipitated and dried cadmium sulphide of the laboratory. It is common in small quantities throughout the district where blende occurs as one of the products of weathering. Occasionally small amounts of greenockite (noted especially at the Old Jim mine) colour smithsonite yellow, and form the variety " turkey-fat." Blende from Golconda, Illinois, gave 0·110 per cent., and ore from the Kentucky fluorspar mine, 0·211 per cent. of cadmium.

Several analyses of zinc ores from Northern Arkansas show a considerable cadmium content. Blende from the Panther Creek mine gave 0·26 ; smithsonite from Wood's mine, 0·43, while smithsonite (" turkey fat ") from the Morning Star mine gave 0·72 and 0·79 per cent. of cadmium.

The calamine ores in the vicinity of Hanover, New Mexico, contain sufficient cadmium to give a strong yellow tint to the zinc oxide made from them.

The Joplin district shows a comparatively large percentage of cadmium, the average of nearly 11,000 shipments, mostly carload lots, being 0·358 per cent. This cadmium may not all be isomorphously mixed with the blende, but may in part represent the secondary greenockite derived by alteration of cadmiferous blende in the zone of oxidation and precipitated below by the reducing action of organic matter. It is not uncommon near the lower limits of the zone of weathering, being most abundant on the surface of blende crystals or on fracture surfaces within them, and is also found on galena, calcite, chert and calamine. As a coating it forms very thin dull films, easily rubbed off with the finger, and with a colour ranging from grass-green through yellowish-green to citron-yellow. Apparently the cadmium sulphide is formed sometimes by replacement, and at other times by precipitation through reducing agents already in solution.

The mine waters in the Joplin region, especially in the districts where mining has been carried on longest, are strongly acid, containing sulphuric acid, zinc sulphate, and smaller quantities of cadmium sulphate.

PRODUCTION AND PRICES

There has hitherto been a limited demand for the metal and its compounds, and the world's average annual production was given about ten years ago as 20 tons, but in 1920 and 1921, it amounted to about 89 and 74 tons respectively. The output has been steadily increasing since. In 1923 the large electrolytic zinc plants produced a good deal of cadmium as a by-product. The output for that year probably exceeded 200 tons, and in the near future may reach 400 or 500 tons per annum.

Hitherto the United States and Germany and Poland (Upper Silesia) have produced the main portion of the world's output of cadmium. The highest output from the above countries was in 1917, with 379,692 lb. (about 169 tons) of metallic cadmium, and 50,169 lb. (about 22 tons) of cadmium sulphide, the latter entirely from the United States. In 1921, the output dropped to 115,988 lb. (about 51 tons) of metallic cadmium, and 65,446 lb. (about 29 tons) of cadmium sulphide. But in 1922, the United States alone produced 131,590 lb. (or nearly 59 tons) of metallic cadmium, and 134,774 lb. (or about 60 tons) of cadmium sulphide.

Prior to 1920, the imports of cadmium into the United Kingdom were not separately specified. In 1922, 23,653 lb. (about 10½ tons) of the metal were imported for the first time from Australia. This cadmium came from the electrolytic zinc works at Risdon, Tasmania. The imports in 1923 must have been greatly in excess of those of the previous year, seeing that the Risdon production in that year, amounted, as already pointed out, to over 100 tons. Cadmium in unrecorded quantities is said to be produced in England and Belgium. The metal has not yet figured in the production statistics of the Consolidated Mining and Smelting Co. of Canada, but there is probably some recovery of it from the electrolytic zinc plant of that company in Trail, British Columbia.

The average London market prices of cadmium in the years 1919, 1920 and 1921, were *7s. 2d.*, *6s. 6d.* and

6*s*. 1*d*. per lb. respectively. In 1922 and 1923, the average prices appear to have been 5*s*. 8*d*., and 4*s*. 7½*d*. respectively, and the current prices (March, 1925) are 2*s*. 6*d*. per lb. in London, and 60 cents per lb. in the United States.

The considerable fall in price is no doubt largely due to the increased production of the big electrolytic zinc plants, especially those of Risdon, Tasmania and Great Falls, Montana.

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NOTES

Imperial Institute Act, 1925.—As an outcome of the Report of the Committee of Enquiry appointed by the Secretary of State for the Colonies in 1923 and of the subsequent resolution of the Imperial Economic Conference (see this BULLETIN, 1923, **21**, 363, 490, 626), an Act of Parliament (the Imperial Institute Act, 1925) has now been passed which repeals the Acts of 1902 and 1916 and provides (1) for the transfer of the Institute to the control of the Parliamentary Secretary of the Department of Overseas Trade; (2) for its management, under that Minister, by a Board of Governors representing all the interests concerned, and (3) for the amalgamation of the Imperial Mineral Resources Bureau with the Institute. Copies of the Act can be obtained from His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2.

Imperial Institute Monographs on Mineral Resources.—A monograph on *Bauxite and Aluminium* by W. G. Rumbold, of the Scientific and Technical Department, Imperial Institute, has just been published by Mr. John Murray, in the series of Imperial Institute Monographs on Mineral Resources, price 6*s*.

The book, of 110 pages, is divided into three chapters, the first of which deals with bauxite and other aluminium minerals, and the marketing, uses, and world's production of bauxite, and also with the properties and uses, commerce and production of aluminium.

The second chapter deals with the deposits of bauxite in the British Empire, including those of Ireland, India, the Gold Coast, British Guiana, and Australia.

The third chapter describes the bauxite deposits of foreign countries, especially those of France, Italy, Rumania, Spain, Dalmatia (Yugo-Slavia), and the United States.

The positions of the chief bauxite occurrences are shown on a map, and the monograph concludes with a list of important publications on bauxite and aluminium.

British Empire Exhibition.—The Imperial Institute is again taking part in connection with this exhibition. An exhibit has been arranged in H.M. Government Pavilion illustrating the work of the Scientific and Technical Department and the Technical Committees of the Institute in promoting the utilisation of Empire raw materials. The specimens represent typical examples of the principal raw materials investigated at the Imperial Institute and are arranged in the following groups: fibres, silk, paper-making materials, timbers, rubber, oils and oil-seeds, tobacco, tanning materials, essential oils, resins, drugs, and minerals. In addition to the raw materials themselves, specimens are also shown of products obtained from them. Each of the paper-making materials, for example, is accompanied by paper made from it in the Institute's laboratories, and, in some cases, at paper-mills. Similarly in the case of essential oils, drugs, etc., the principal constituents, isolated at the Institute, are exhibited, and, in the case of tanning materials, specimens of leather tanned with them are shown. With regard to minerals, specimens of bricks, tiles, pottery, and cements prepared in tests carried out at the Institute are on view. The collection also includes copies of the principal publications of the Institute, and photographs are shown of the Institute, of its laboratories, and of certain typical exhibits in the Public Galleries.

As was the case last year, illustrations of the work of the Institute may also be seen in other sections of the Exhibition.

Ceylon Rubber Research Scheme.—The annual general meeting of subscribers to the Scheme (see this BULLETIN, 1925, **13**, v.), was held at Kandy, Ceylon, on March 14, 1925. The detailed reports on the work in Ceylon and London, a summary of which is given in the following pages, show that during 1924 the Scheme made steady progress.

The receipts from local subscribers in the Colony amounted to Rs.24,417 as compared with Rs.16,700 in 1923, and Rs.9,312 in 1922. As in 1923–24, grants of £2,000 and Rs.67,500 were made by the Rubber Growers' Association and the Ceylon Government respectively.

Two new bungalows were erected during the year and accommodation is now provided for all the scientific officers working in the laboratories on Culloden Estate, Neboda. The laboratories built in 1923 have been fully equipped for the various researches which are being carried out. Endeavours are being made to secure a suitable block of land within easy reach of the Research Scheme laboratories for conducting experimental work on budding, seed selection, cover crops, etc.

The Organising Secretary, Mr. J. Mitchell, A.R.C.S., not only performed the secretarial work in Ceylon, but also visited 68 estates during the year and issued a full report on each for the information of the Superintendents, Agents and Directors. Detailed instructions and demonstrations regarding the symptoms and treatment of diseases were given, and problems in the field and difficulties in the factory were dealt with. Mr. Mitchell considers that there has been an improvement in the position as regards root diseases, but that there is still need for further research on the Brown Bast problem and on what are known as the Phytophthora diseases of rubber (bark rot, patch canker, top canker, secondary leaf-fall, and pod disease). It would appear that Brown Bast is more prevalent in Ceylon than is generally thought to be the case and that the operation of restriction of output may conceal cases which would otherwise be known and recorded. In cases where a careful census was taken the number of affected trees was usually much greater than was anticipated. Pink disease was recorded on several estates, but in no case was there any serious outbreak. Very few complaints were received regarding smoked sheet, and it is probable that "rust" (which was the principal trouble in 1922 and 1923) is now being satisfactorily avoided. The chief complaints received in connection with crêpe rubber related to spots in sole crêpe, and recommendations were made for dealing with this defect.

The Chemist in Ceylon, Mr. T. E. H. O'Brien, B.Sc., has given special attention to the development of a glass hydrometer suitable for use in Ceylon, and arrangements are being made for it to be thoroughly tested on estates in Ceylon and Malaya. Work on the mineral constituents of latex and on the effect of different conditions of smoking on the development of mould was carried out during the year and is being continued. Experiments are in progress in connection with the use of formic acid as a coagulant and on the effect on raw and vulcanised rubber of spraying the trees with Bordeaux mixture.

The Physiological Botanist, Mr. R. A. Taylor, B.Sc., returned in March from his visit to Java and the Federated Malay States, where he had made a special study of methods of physiological research and of the work which was in progress on seed selection and budding. He has since continued his study of Brown Bast in the laboratory and in the field. Further experiments on the effect of the change-over system of tapping were conducted during the year and are being continued. In connection with the budding of rubber, selected seeds from the Heneratgoda No. 2 tree were planted in nurseries to supply stocks for budding during 1925. Efforts are being made to secure records of the trees giving exceptionally high yields, so that a study can be made of the influence of different soils and climatic conditions on budded rubber. Other questions under investigation include the composition of cell sap and the relationship between the reaction of soil solutions and the amount of organic matter present. The problem of manuring and the growing of cover crops are also receiving attention.

Mr. Park's reversion to his former appointment as Assistant Mycologist to the Department of Agriculture deprived the Scheme of a Mycologist for the first nine months of the year. His successor, Mr. R. H. Stoughton-Harris, B.Sc., A.R.C.S., is giving special consideration to the subject of the Phytophthora diseases of rubber and is making a study of the various disinfectants in use. He is supervising the pollarding and spraying experiments in connection with the problems of secondary leaf-fall and pod disease, and will collaborate with the Physiological Botanist in the investigation of Brown Bast.

The principal investigation in progress at the Imperial Institute in connection with the Scheme was a continuation of the study of the variability in time of vulcanisation of plantation rubber. Experiments previously carried out had indicated that unsmoked sheet rubber from certain estates almost invariably vulcanised much more slowly than that from other estates, and it was accordingly decided to study this question further and to determine whether other forms of rubber show a similar variation. At the same time it was considered desirable to investigate whether seasonal variations occur in Ceylon rubber and whether differences in estate conditions, e.g. soil, elevation, climate, etc., influence the results. The examination of a comprehensive series of 90 samples was completed during the year and a report on the results will be found on pp. 135–149 of this issue of the BULLETIN.

In view of the statement by manufacturers that variations in the plasticity of rubber have a serious effect on factory operations, a special apparatus has been designed and constructed at the Imperial Institute for measuring plasticity in order to determine the extent and cause of the variation in plantation rubber in this respect, and tests are now in progress. A preliminary set of experiments has been carried out with an apparatus which was constructed to compare the adhesive properties of solutions of rubber.

In connection with questions raised by the Research Association of British Rubber and Tyre Manufacturers as to the suitability of plantation rubber for certain manufacturing purposes, an extensive series of samples containing different amounts of moisture were prepared in Ceylon and, at the close of the year, were being submitted to special tests in comparison with fine hard Para.

The Staff in London also examined a number of samples prepared by the Chemist in Ceylon in connection with his experiments on smoking and other subjects. Further work was carried out on the effect of the use of sodium silico-fluoride as a coagulant and on Hopkinson sprayed rubber.

The possibility of securing greater standardisation in the methods of testing rubber was further considered in communication with the Central Rubber Station, Java, and the American Chemical Society, and tests were made in conjunction with the Central Rubber Station with a view to determining the effect of differences in the methods employed.

As a result of enquiries made of brokers regarding the suitability of recent shipments of sole crêpe from Ceylon, samples of the grades at present in demand, approved by the Standard Qualities Committee of the Rubber Trade Association, were forwarded to the Colony for the information of estate superintendents.

Visits were paid by the Staff in London to the factories of Messrs. Henley's Telegraph Works Co., Ltd., and the Dunlop Rubber Co., Ltd., as a result of which much useful information was obtained. The Staff also attended the Conference held under the auspices of the Rubber Growers' Association and the Research Association of British Rubber and Tyre Manufacturers at which the Chairman of the Ceylon Committee read a paper on the work of the Scheme. A paper on the subject was also prepared for the Conference held in connection with the International Exhibition of Rubber and other Tropical Products at Brussels. These papers were published in the Proceedings of the respective Conferences.

An exhibit illustrating the work conducted in London for the Scheme and the methods of testing employed was included in the Imperial Institute Section of the British Government Pavilion at the British Empire Exhibition.

In accordance with the announcement made in the last report, quarterly circulars containing a series of articles on current problems were circulated to all subscribers. Arrangements were also made for the exchange of progress reports between the staffs of the Ceylon Rubber Research Scheme and the Rubber Growers' Association with a view to securing closer co-operation between the research officers in Ceylon and Malaya.

Mineral Resources of British Somaliland.—A review of the mineral resources of British Somaliland, so far as they were then known, was given in this BULLETIN (1924, **22**, 65), and it was stated that a mineral survey of the country was being conducted by Mr. R. A. Farquharson, under the direction of the Colonial Office. The samples of economic interest collected during the first year of the survey have been examined chemically by the scientific staff of the Imperial Institute. On Mr. Farquharson's return to this country he was given accommodation at the Institute for the purpose of working up his results, technical information on certain points was supplied to him, and the Institute's records concerning minerals received previously from Somaliland were placed at his disposal. The results of the first year's work are incorporated in a *First Report on the Geology and Mineral Resources of British Somaliland* recently issued (Waterlow & Sons, Ltd., 1924, foolsc., 53 pp., with map. Price 5*s*.).

In such a short time the author naturally was not able to obtain enough information to enable him to give a full account of the geology of the country, but his general conclusions are recorded.

The principal series into which the succession of rocks is divided are (1) a basement crystalline series of gneisses and schists with intrusive dykes referred to the Archæan and pre-Cambrian epochs; (2) the Inda Ad slates, apparently non-fossiliferous, but probably of Palæozoic or pre-Palæozoic age, and possibly corresponding to the Karagwe series of the Transvaal; (3) a Jurassic limestone series (Kimmeridgian); (4) the Durbar sandstone, regarded as of Cretaceous age; (5) an Eocene limestone series, probably up to 2,000 feet thick in places; (6) the gypsum series, of similar thickness, lying conformably on the Eocene limestone and probably of Miocene or perhaps Pliocene age; (7) the Daban series of sandstones and clays attaining a thickness of 10,000 feet, which appear to be of Pliocene age; (8) post-Daban conglomerates and sandstones, probably Pliocene; and (9) a coastal limestone series, also post-Daban. In addition to the raised coral reefs along the coasts and recent accumulations of gravel and sand there are lava flows of different ages, pre-Jurassic, Jurassic and late Tertiary.

The author's objectives were mainly economic. He describes occurrences of the following minerals: coal, lignite, galena, salt, petroleum, guano, mica, beryl, garnet, barytes, celestite, gypsum, molybdenite, clay, talc, marble, manganese ore, oil shale, and graphite, and also alludes to doubtful areas where gold and diamonds are believed to exist.

Of the minerals found, coal is by far the most likely to be of economic value in the immediate future. It was found about 12 miles south of Ankor in Hedhed tug, and is evidently the same as that previously examined at the Institute (see this BULLETIN, 1915, **13**, 189) which was said to have come from Ambal Hill, at which locality, however, Mr. Farquharson could find no trace of coal. The average thickness of the seam is 2 ft. 6 in., but its extent could not be ascertained beyond the observed 100 yards of outcrop, owing to its being obscured by river gravel and other débris. Samples were taken 18 inches from the surface, and these compared very favourably with samples of Nigerian sub-bituminous coal obtained from surface outcrops before the Nigerian coalfield was opened up.

Lignite is recorded for the first time from Somaliland. It is a lustrous black lignite occurring in a seam 1 ft. to

1 ft. 6 in. thick, near Khal Der well, within easy distance of Berbera. Analyses showed that it is of promising quality, but contains much sulphur. There is no connection between the coal and the lignite.

Galena was found at two separate localities in the Inda Ad slates. Whilst satisfactory as ores of lead, the samples were too low in silver content to constitute valuable ores. The occurrences appear to be sporadic, but are interesting as showing that sulphide ores may be met with in this series of palæozoic slates.

The petroleum and salt deposits have already been dealt with in this BULLETIN (1915, **13**, 189, 190).

The deposit of guano on Mait Island, a few miles off the coast opposite Hais, has not yet received expert examination and Mr. Farquharson was not able to reach it, but he collected information from natives who had worked it (for until lately the Sultan of Makulla has used the phosphate for manuring tobacco crops), and took a sample of the material from bags in the Customs House of Berbera. It consisted of fragments of various igneous and sedimentary rocks, a little phosphate, and some bones and feathers.

The probable occurrence of large quantities of marketable mica was confirmed, but the most promising area was not visited, and the surveyor had no explosives wherewith to obtain any but inferior samples of surface material from the large books which he encountered on the Mirsa Plateau. Beryl and coarse weathered garnet which might perhaps prove to be of commercial interest are associated with the mica in the pegmatites of this plateau.

The other minerals do not call for special mention, being either of comparatively small commercial interest or of very limited extent.

The report then deals with the important question of water supply and concludes with recommendations as to the areas in which further work is desirable and the methods which ought to be pursued. A map is appended showing the author's route and the locations of the mineral deposits, but owing to the lack of sufficient information, the geological boundaries are not shown.

New Lignite Deposits in Nigeria.—There appeared in this BULLETIN (1923, **21**, 325) a full article on the lignite deposits of the Southern Provinces, Nigeria. Since that date samples sent by the Geological Survey of Nigeria from areas not described in that article have been examined at the Institute. The new localities are (*a*) in the neighbourhood of Umu Ahia, west of Bende on the Eastern

Railway, and (*b*) probably near Ossidinge on the Cross River in South Cameroons. The samples in the latter case were brought in by natives and nothing is known as to the extent of the deposits, which have not been seen *in situ*.

The Umu Ahia deposits have been described briefly by R. C. Wilson in *Occasional Paper No.* 1, 1924 (*Revised edition,* 1925, pp. 12–15), and more fully in *Bull. No.* 8, 1925, *Geol. Surv., Nigeria,* pp. 79–85. The lignite was first found by two Divisional Officers in 1919 in the Imo River and its tributary the Aham, but the Lignite Group has since been found to occupy a strip of country 4 to 8 miles wide and about 18 miles long running approximately N.W.—S.E., just south of Umu Ahia station, which is about 70 miles from Port Harcourt on the Eastern Railway.

To the north the Lignite Group overlies the Bende-Ameki Group, whose geological age is considered to be upper-middle Eocene, but it is not known whether the succession is conformable. The series consists of thick beds of greyish-white or mottled, gritty clays, alternating with seams of lignite varying from 1 ft. to 4 ft. 2 in. in thickness. The principal outcrops are in the head-streams of the Oyivo River and the Iyi Ogwe, near Umu Ahia, just west of the railway, and near Amawon in the head-streams of the Iyi Yukwu, 6 to 8 miles east of the railway. The samples examined were distinctly woody, and analyses made at the Imperial Institute indicated that they were inferior in quality to those from the Niger Valley. They were, however, only outcrop samples with a high moisture content. The results of the analyses of two of the samples were as follows :

	Ogwe River. *Per cent.*	Oyivo River. *Per cent.*
Volatile matter	32·27	35·28
Fixed carbon	25·26	29·11
Ash	10·57	4·89
Moisture (at 105° C.)	31·90	30·72
Sulphur	3·01	3·52
Calorific value (small calories)	3,349	3,726

The Lignite Group is non-fossiliferous and in this area is unconformably overlain by Benin Sands to the south.

Mr. Wilson considers that this Lignite Group may be continuous with the similar beds met with to the westward in the Niger valley near Newi and Asaba, but he thinks that the Moroko lignite (from near Abeokuta) may have been laid down at an earlier date. The clays with which the lignite is associated have been found at the Imperial

Institute to be suitable for the manufacture of certain classes of native pottery or, when suitably treated, for making bricks. Owing to their proximity to the railway, these deposits of lignite and clay are favourably situated for exploitation.

Platinum in South Africa.—Two important papers concerned with the Lydenburg platinum discoveries have recently appeared. In *S. Afr. Min. and Eng. Journ.*, Feb. 7, 1925, p. 581, was published an abstract of a paper read to the Geological Society of South Africa by Drs. P. A. Wagner and E. T. Mellor, in which the lower of the two horizons at which platinum has been found recently is described in some detail. At this horizon, the platinum-bearing rock is described as hortonolite-dunite, i.e. an igneous rock composed essentially of the iron-rich variety of olivine known as hortonolite. Such a rock had not hitherto been found to constitute an extensive sheet. Assays have shown this rock to contain up to 33·8 dwts. per ton on the farm Onverwacht. In alluvial deposits derived therefrom platinum occurs in well-formed cubic crystals or crystal aggregates, and also irregular grains or nuggets up to 5 millimetres in length. This paper, which was principally devoted to the purely scientific aspect of the occurrences, drew a parallel between these Lydenburg deposits and those of the Ural Mountains.

In *S. Afr. Journ. of Industries* (1925, **8**, 90), there appeared the official report on the Lydenburg deposits by Dr. P. A. Wagner. This report, which is illustrated, occupies 27 pages and enters fully into the historical, scientific and economic aspects of the discoveries. Much of the information has been given in previous articles, already noticed in this BULLETIN.

Dr. Wagner divides the deposits into (1) Primary, (2) Eluvial and Rubble, (3) Alluvial. The primary deposits occupy two fairly definite horizons in the lower part of the norite zone, which occupies the outer and lower portion of the huge, irregularly oval-shaped body of igneous rocks, occupying the central Transvaal, known as the Bushveld Complex. The norite zone is basin-shaped and some 3 miles in thickness. Of the two horizons, the Lower, which lies between two chromite horizons, is that in which, as stated above, platinum is associated with hortonolite-dunite; this rock occurs as isolated lenses, stratiform segregations, and irregularly shaped bodies. The Upper or Main horizon is about 1,600 feet above the Lower, and in it the platinum is associated with a very persistent sheet of pyroxenitic diallage norite, varying in thickness from 3 to 40 feet. Platinum has also been found in rocks above and below this horizon.

Considerable accumulations of platiniferous eluvium and rubble have resulted from the weathering of rocks of the Lower horizon, and on Mooihoek kopje alone 3,000 tons of this material, carrying 3 to 13·7 dwts. of platinum per ton, have been proved, and many other accumulations are known to exist. The only great alluvial deposit in the area is that at Fort Burger on the Steelpoort River, but whilst it is known to be platiniferous, no assay values are given. The report concludes with a list of the 16 companies operating at the time of its compilation, with details of their respective properties.

In addition to the papers mentioned above, reference may be made to the issue of the *S. Afr. Min. and Eng. Journ.* of Mar. 21, 1925, a special platinum number, in which a résumé of what had previously appeared in print was given, together with the latest information from properties in each of the platinum areas. The prospects of finding deposits of economic value in the Rustenburg, Potgietersrust and Middleburg districts were also discussed.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the B*ULLETIN a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Tea.—At Bandoeng, Java, a congress and exhibition were held in June 1924 to celebrate the centenary of tea planting in the Dutch East Indies. *Commercial Holland* (1925, **5**, No. 56, p. 19) contains an article in which the tea production of the world is briefly reviewed and the past history and present position of tea in the Dutch East Indies are fully set out. The first tea seed was brought to Java by von Siebold from Japan in 1824, but the industry was actually founded by Jacobson in 1827 on behalf of the Nederlandsche Handel Maatschappij. Tea growing in Java remained an insignificant industry until 1860, when the Government abandoned control and leased the State gardens to private persons. In 1877 producers sent specimens of their tea to London, and the English brokers pointed out its defects and sent out Indian samples for comparison; as a consequence in 1878 the Java planters procured Assam seed. Among the Englishmen who contributed much to the improvement of Java tea was John Peet, who arranged the first shipment from Batavia to London, which soon became the chief market for Java tea. In 1923 there were 261 tea estates in Java and 28 in Sumatra. The total area planted with tea was 198,588 acres in Java and 29,146 acres in Sumatra, the production of tea from this area being about 40,000 tons. To the above plantations should be added about 47,000 acres of native plantations in the Preanger Regencies, where the so-called "kampong tea" is grown; the production of this tea, which amounted to 8,900 tons in 1923, is confined to this district. The amount of capital invested in tea in the Dutch East Indies is said to be 103,000,000 guilders, of which 61,000,000 is in Dutch hands and 30,000,000 in English, more than half of the capital on the East Coast of Sumatra being English.

Wheat.—The records of some 170 wheats tested at Brandon since 1889 are contained in *Bull.* No. 42, *New Series* (1925), *Dept. Agric. Canada,* entitled "Experiments with Wheat at the Dominion Experimental Farm, Brandon, Manitoba. A Summary 1889–1923." Fifteen varieties of hard red spring wheat and a few varieties of durum wheat and of winter wheat were still under test in 1923; the reasons for discarding the other varieties are explained. The data regarding the wheats retained include yield per acre, earliness and weight per bushel. Of the spring wheats still under trial, Marquis, which now constitutes probably over 75 per cent. of the Manitoba crop, outyielded all the others, but at the same time its susceptibility to rust has brought about general dissatisfaction with this variety. There is a widespread search for something to take its place, and if a satisfactory substitute could be found, it would rapidly be adopted. The only hard red spring wheat in the test which shows resistance to black stem rust is Kota, a variety produced at the North Dakota Agricultural College, but this has some serious faults, the worst being its weak straw.

Other experimental results discussed in the *Bulletin* concern seed, seeding, summer-fallow, rotation, cultivation (including treatment of stubble and sod land), manures, and cost of production on summer-fallow and on stubble land.

Taros and Yautias.—*Dept. Bull. No.* 1247, 1924, *U.S. Dept. Agric.*, entitled " Taros and Yautias, Promising New Food Plants for the South," deals with the characters and varieties of these starchy root crops, which are similar to the potato in food qualities. The taros belong to the genus *Colocasia*, while the yautias are species of *Xanthosoma*. Several species of each genus are of considerable importance as food plants in various parts of the tropics and sub-tropics, and certain varieties have proved suitable for cultivation as annual crops in the Southern United States, where, maturing in the autumn or early winter when home-grown potatoes are scarce, they are of special value. The most important type of taro in the United States is the dasheen, a more or less distinct group belonging to the species *Colocasia esculenta*, (L.) Schott. The three most promising varieties of dasheens, the Trinidad, Sacramento, and Ventura are dealt with in *Farmers' Bull. No.* 1396 (1924), where cultivation, marketing, composition, digestibility, and uses are fully discussed.

Oils and Oil Seeds

Coconuts.—*Bulletin No.* 36, 1924, *Dept. Agric. S.S. and F.M.S.*, deals with investigations on the red stripe weevil of coconuts (*Rhynchophorus schach*, Oliv.) started in 1920 by the Department of Agriculture, Federated Malay States.

This weevil is only injurious in the larval stage. Soon after hatching, the larva begins gnawing and boring through the tissues and may reach the heart of the " cabbage." Infection of the crown of both old and young trees is characterised by the central shoots falling down. If the growing point of the palm is not affected, the death of the palm will not take place unless the damaged tissues become infected by fungoid disease.

The period of incubation of the eggs is just under three days. Experiments showed that the weevils were unable to lay eggs in the crowns or at the base of leaf petioles unless these had previously been damaged, and that the grubs will not enter the palm through incisions in the bark less than 1 in. deep (such as " toddy steps ") or through compact tissues. There is a possibility that eggs may be deposited in the cut ends of petioles or on leaf scars.

The trapping of these insects cannot be recommended as a general practice. Where, however, coconut palms are badly infested and "nibong" and especially sago palms are available, pieces of the stems of these two palms may be used with advantage, particularly if the insects are collected and destroyed and a fresh surface is exposed each day. Experiments showed that burying infected palms even 3 ft. below the ground could not be advocated, as the weevils are capable of escaping through this depth of soil. Covering felled palms with 1 in. of sand prevented eggs from being laid on them, but this method of preventing waste material from becoming breeding places cannot be recommended, owing to the difficulty of deciding whether the material is free from eggs, prior to burial, and to the constant supervision necessary to prevent the wood from becoming exposed through heavy rain.

As precautionary measures of control, it is recommended that, as eggs are not laid on sound trees, care should be taken to prevent injury to the palms by insects, storms, or by cutting toddy steps too deep, or cutting or pulling off leaves and spikes. All wounds should be tarred twice. All likely breeding places should be destroyed, preferably by burning. Trapping and collecting weevils may also be practised, but only if they are present in sufficient quantity. Remedial measures consist in destroying all palms suffering from crown infection. In cases of trunk or root infection, the diseased tissue should be cut away and the exposed surface disinfected. If the resulting cavity be small, it may be filled with cement, but such treatment in the case of large cavities may not be profitable.

The question of variation in coconuts is discussed with particular reference to fruit production in *Malayan Agric. Journ.* (1925, **13**, 25). Figures taken from the records of the Carey Island plantation are given, which show that good producing trees on the average remain proportionately good yielders from year to year, while poor yielders continue to produce poorly. Further data are published to demonstrate the variation in the number of ripe fruits per picking per palm; the variation in the time taken by the palms to reach maturity; and the variation in fruit production per palm.

This statistical evidence shows definitely that there is a wide range of variation in fruit production per palm. This variation cannot be ascribed to varying soil conditions, for good and poor producing palms frequently stand side by side; moreover, alluvial clay soils are notable locally for their uniformity. An inspection of the recorded figures demonstrates the necessity for selection in coconut planting.

Oil-Palm.—The work of selection of oil-palms in a country or district is usually carried out in two stages. The first stage consists of a primary selection of the palms already growing in the forests or plantations in order to isolate the palms whose descendants should be experimented on in the station (*Agron. Colon.*, 1925, **12**, 1). The second stage is a true or pedigree selection carried on with the trees thus isolated. The researches now being made in the selection of oil-palms in Dahomey are at present confined to the first stage and the trees which have qualities distinguishing them from the average are being studied. So far the oil-palms growing in the forests and plantations have been classified into the following three groups.

The first group with black fruits is sub-divided into four sections, depending on the thickness of the shell. De-Yaya is the variety most frequently met with in Dahomey. Its shell is the thickest and the pericarp least abundant. It represents 90 per cent. of the oil-palms in the country. The other three sections of this group are represented by De-Kla, De-Gbakoun, and Votchi. The first-named has a slightly thinner shell and more abundant pericarp than De-Yaya ; its fruits are very oily and split on reaching maturity. De-Gbakoun has much pericarp and a shell which is so thin that it can be broken by the teeth. In the Votchi variety the nut has more or less disappeared. This form is considered to have been evolved from De-Yaya and is sterile. In some cases the fruit consists of only a tuft of fibre and a kernel the size of a pea.

Kissede constitutes the second group, and presents, although to a lesser degree, the same variations in the thickness of shell and amount of pericarp as are shown in the first group. Its fruits are green when young. This variety does not present any superiority over De-Yaya from an economic point of view, as generally its shell is too thick.

The third group comprises Fade, the fetish palm, the leaflets of which are joined together. From the point of view of selection, the first group is most worth study, especially the varieties De-Gbakoun and De-Kla.

Besides these varieties, there occur in Dahomey and also in the Ivory Coast special forms of the oil-palm (*loc. cit.*, 1924, **11**, 129). The oil-palm normally bears successively spikes of male flowers and female flowers (see this BULLETIN, 1920, **18**, 220). Considerable modifications of the typical forms have been observed in the course of an inspection of the oil-palm forests of Dahomey and the Ivory Coast. Cases of hermaphroditism in the oil-palm occurring in these countries are described and illustrated, as are also cases of viviparous palms growing at Bingerville, Ivory Coast. In the latter, leafy shoots, resembling young palms, are borne in the axils of the leaves instead of the flowering shoots. Such palms are remarkable for their foliage, which is generally twice as abundant as in the case of the ordinary palm. Hermaphroditism does not appear to be a constant characteristic of a given palm, and observations have not been made over a long enough period to determine whether certain varieties of palms have a special susceptibility in this direction. The question, however, deserves to be followed up, for, if hermaphroditism of the spikes accompanies auto-fertilisation, the work of selection would be simplified, provided that regimes are yielded in which the proportion of male organs is so reduced as not to diminish the economic value, and provided also that this characteristic is passed on to the descendants, which, however, appears very doubtful.

Notes on germination trials with oil-palm fruits are given in *Bull. Agric. Congo Belge* (1924, **15**, 677). In sowing these fruits or nuts it is impossible to foretell the number that will germinate or the time that will be required. The latter is dependent on the degree of maturity of the fruits when gathered, ripe seed germinating more rapidly than unripe or over-ripe seed. It has been found that freshly collected fruits germinate more readily than those that have been stored. This explains why seed imported from West Africa to the East Indies often takes a year to germinate. The germination is also affected by the temperature of the soil, as has been shown by experiments, conducted at Eala, with the fruits of *Elaeis guineensis*, var. *communis*, subvar. *dura*. Only a small proportion had germinated after six months when planted in a medium of dead leaves, moss, etc., in a cask, the lighting and humidity being made as similar as possible to those in the natural surroundings. Similar results were obtained on planting in shaded and unshaded beds. When, however, the nuts were sown in boxes covered with frames and warmed by a thermo-siphon system, the temperature of the soil being nearly constant at 40° C., after six months 80–90 per cent. of thick-shelled nuts had germinated as compared with 76 per cent. for the thin-shelled variety. The removal of the pericarp is stated to hasten the germination, as the moisture can then get to the nut more readily.

RUBBER

Hevea

South American Leaf Disease.—R. D. Rands, in *Dept. Bull. No.* 1286, 1925, *U.S. Dept. Agric.*, points out that the revival of interest in rubber cultivation in the American tropics has stimulated a review of past attempts and a study of the factors which may determine the success or failure of new enterprises. The discouraging results of formerly promising rubber plantations in the Guianas are due to leaf disease, which is the most serious trouble affecting the cultivated rubber tree in South America. It not only makes tapping unremunerative, but repeated defoliation may lead to extensive die-back of the branches and eventually to the death of the tree. The optimum conditions for the epidemic spread of the disease are (1) the continuous presence of young foliage, and (2) abundance of moisture on the plant each day for a period of 10–12 hours. Of the numerous suggestions made in the past for controlling the leaf disease, none appears to have been practicable. Attention is called to the possibilities existing in the deserted Guiana plantations for the selection of disease-resistant strains of rubber.

Rubber from Latex preserved with Ammonia.—As the behaviour on mastication and during the vulcanisation of rubber from latex preserved with ammonia may be of importance for some manufacturing purposes, the results of experiments by O. de Vries, R. Riebl, and N. Beumée-Nieuwland (*Archief v. de Rubber Cultuur*, 1925, **9**, 345) are of interest, especially as these investigators paid particular attention to the age of the preserved latex. They find that immediately on adding ammonia, the viscosity of the latex is reduced and within a few hours it gives a rubber which is more plastic and vulcanises more quickly than that prepared from fresh latex. After the first few hours have elapsed, the viscosity of the latex increases, as do also the plasticity and time of vulcanisation of the rubber prepared from it. After two or three months the viscosity of the latex and plasticity and time of vulcanisation of rubber prepared from it gradually decrease, until after fourteen months they reach very low values.

Packing of Rubber.—The present method of packing rubber in wooden cases has the serious disadvantage that almost invariably rubber which was kept scrupulously clean on the plantation becomes contaminated with splinters by the time it is ready for use by the manufacturer. In *Bulletin Rubber Growers' Assoc.*, Feb. 1925, p. 111, and March 1925, p. 175, Dr. de Vries recommends wrapping the rubber in a rubber casing and enclosing the whole in a tobacco mat. Tobacco mats are a superior kind of packing material, made from a type of rush occurring abundantly in south-east Borneo. A full, illustrated description of the method of packing, together with the opinions of manufacturers, is given. The advantages of mat-packing are summarised as follows :

(1) The rubber remains clean ; (2) the tare is small and very uniform ; (3) packing repairs are easy and cheap ; (4) mats are easily and quickly opened and closed again ; (5) mats are preferred by dock workers, because they are easy to handle and free from nails.

Cryptostegia grandiflora

In the *India Rubber World*, March 1, 1925, p. 339, Charles S. Dolley claims that when satisfactory appliances for the extraction of the rubber have been devised, the culture of *Cryptostegia grandiflora* will assume large proportions, because it is a plant that can be grown in most places which are free from frost. Reports on samples of this rubber examined at the Imperial Institute have been given in this BULLETIN (1907, **5**, 371 ; 1912, **10**, 210), and it was shown in some cases that the commercial value of the rubber was only a little inferior to that of fine hard Para. *Cryptostegia grandiflora* is a woody twiner, indigenous to Madagascar, Mauritius and Western India, and was introduced to the West Indies thirty-five years ago. According to Dolley, the plant can be very easily propagated from seed, which germinates readily, and the young nursery plants stand transplantation well. A yield of 400 lb. of rubber per acre may be expected, and harvesting may begin within two years of planting.

ESSENTIAL OILS

Citrus Oils.—Several interesting articles on citrus oils have been contributed to *La Parfumerie Moderne* (1925, **18**, 45). Attention is drawn to the growing industries in orange oil in America and other parts of the world and their effect on the Italian product. According to E. J. Parry, Australian lemon oil is of fine aroma, and only inferior to the Sicilian oil on account of its lower citral content. In one article a new machine for the extraction of oil from citrus fruits is described by the inventor, G. Ajon. It is an elaboration of the sponge extraction method, and when run by a 1 h.p. electric motor, is said to be able to deal with 1,000 lemons in twenty-five to thirty minutes. G. Ajon also describes a method for the detection of terpenes and citral as adulterants in lemon oil.

Indian Essential Oils.—Two further studies of Indian essential oils, by J. L. Simonsen, have been published (*Ind. For. Rec.*, 1924, **11**, 1). The seeds of *Zanthoxylum ovalifolium*, a plant fairly widely distributed in the Indian Peninsula, furnished about 0·3 per cent. of oil, consisting almost entirely of myrcene and safrole in about equal proportions. Oils from the seeds of other species of *Zanthoxylum* occurring in India which have previously been examined have shown remarkable differences in their composition :

Species.	Chief constituents.
Z. alatum	α-Phellandrene, linalol.
Z. acanthopodium	Dipentene, α-phellandrene, linalol, methyl cinnamate.
Z. Budrunga	Sabinene.

Juniperus communis occurs in the Western Himalaya at 5,500 to 14,000 ft., extending eastward to Garhwal and Kumaon. A sample of berries from the Upper Bashahr Div., Nichar, yielded only about 0·2 per cent. of oil, which contained about 50 per cent. of *d*-sabinene with small amounts of terpineol, *l*-cadinene, and a considerable quantity of high boiling constituents, probably sesquiterpene alcohols. The composition of this oil resembled that of savin oil, *J. sabina*, and differed from that of European juniper berry oil which contains α-pinene, camphene, cadinene, and a small amount of oxygenated constituents.

FIBRES

Cotton

Cotton Grading.—In the *Empire Cotton Growing Review* (1925, **2**, 117) brief accounts are given of the systems of cotton grading which are now being practised in the Sudan, South Africa and Queensland.

In the Sudan, the cotton grown under the Gezira scheme is graded at the Sudan Plantation Syndicate's ginning factories. The seed-cotton is brought to the factory in bales, which weigh about 400 lb. each, and bear the tenant's name and number. The cotton is graded before ginning.

The account of the grading in South Africa is contributed by Th. G. Hesse, the Government Cotton Grader. Grading facilities were first provided by the Government in the 1920–21 season, the services of the grader being placed at the disposal of all cotton farmers. The advantages thus offered were evidently greatly appreciated, as 65 per cent. of the crop was submitted for grading before export. Subsequently it was considered advisable that all cotton should be graded in order to establish South African cotton firmly in the world's markets, and grading was made compulsory by proclamation in April, 1923. Special regulations have been made regarding the methods by which samples must be prepared by the ginners for submission to the Government graders. As most of the cotton consists of American Upland varieties, the grading is based on the Liverpool classification for American cotton. A nominal fee of 1*s.* per bale is charged for grading. Each bale exported bears the registered mark of the ginner, the number of the bale, and the type mark assigned by the grader. There are two graders, one being stationed at Pretoria and the other at Durban. In addition to grading, their duties include lecturing to the growers and giving advice regarding markets, prices, etc.; they have also been of assistance in connection with seed selection and the establishment of good varieties.

The subject of cotton grading in Queensland is dealt with by G. Evans, C.I.E., M.A., Director of Cotton Culture, and L. L. Gudge, Government Cotton Classer. After reviewing the causes which rendered grading necessary, an account is given of the first attempts at grading and the appointment of a Government Cotton Classer in 1923, and also of the training of men as cotton graders who had already had experience in wool classing, and for this reason could learn to grade more quickly than others whose eyes had not been accustomed to such work. The schedule of grades and guarantees adopted for the 1924–25 crop are as follows:

Seed Cotton Grade.	*Corresponding Lint Grade.*	*Guaranteed Price per lb. of Seed-cotton.*
A	Middling fair	5¼*d.*
B	Strict good middling	5¼*d.*
C	Good middling	5*d.*
D	Strict middling Middling	4¾*d.*
E	Strict low middling Low middling	4½*d.*
F	Strict good ordinary Good ordinary	4*d.*
G	Strict ordinary Ordinary	3½*d.*

Immature and Spotted Grades

1 x	Good middling to strict Good middling spotted	4¾*d.*
2 x	Strict low middling to middling spotted	4½*d.*
3 x	Strict ordinary to strict good ordinary	3½*d.*

This schedule was subsequently adopted throughout the Commonwealth for the 1924–25 season.

A Government grader is stationed at each ginnery during the season, and draws his samples from the press-box into which the lint falls after leaving the condenser. Owing to the uneven length of much of the cotton hitherto produced in Queensland it has not been possible to staple the cotton in addition to grading it. This mixed Upland cotton is now, however, being replaced by pure varieties, such as Durango, of which about 11,000 acres were planted in the 1924–25 season. This crop is stapled by numbers; thus No. 1 denotes $1\frac{1}{16}$ in. staple; No. 2, $1\frac{1}{8}$ in.; No. 3, $1\frac{3}{16}$ in.; and No. 4, $1\frac{1}{4}$ in.

Egypt.—The question as to the advisability of growing cotton for a second year as a ratoon crop has recently been much discussed, particularly in connection with the Queensland industry (see this BULLETIN, 1924, **22**, 499; 1925, **23**, 74).

The subject is now being studied by the Ministry of Agriculture, Egypt, and a preliminary report by James Templeton, B.Sc., Botanist to the Ministry, has just been published as *Bulletin No.* 55, *Technical and Scientific Service* (*Botanical Section*), *Egypt* (1925).

The cultivation of cotton in Egypt on an extensive scale was commenced about 1821. The plant was at first grown as a perennial, and was usually left in the ground for three years. At a later date some of the growers adopted annual planting, this change being made first on the better estates. The new method was probably undertaken in order that the land might be available for winter crops, and also to enable the soil to be more thoroughly cultivated. The perennial method, however, persisted over large areas until 1912, when it was prohibited by the Government, as it was thought that if the plants were allowed to remain for more than one year, they would harbour insect pests during the winter, and therefore be increasingly attacked in the following season. It was solely on account of this official action that the perennial method was eventually abandoned. In some of the northern districts of the Mudirîyas of Beheira, Gharbîya and Daqahlîya, where the land is poor and unsuitable for such crops as wheat, maize and millet, there are cultivators who still desire to grow ratoon cotton, as they maintain that, owing to the climatic conditions of these localities, it is advantageous to leave the plants for a second season in order to obtain a remunerative return.

There is not very much evidence available with regard to the effects of ratooning in Egypt, b[illegible] as exists indicates that the cotton plant gives a l[illegible]eld in the second year than in the first and that there is no serious deterioration in the quality of the lint. It is pointed out, moreover, that as a general rule a perennial shrub is not expected to give its best crop in the first year, either in respect of yield or quality of fruit, and that there is no apparent reason for the supposition that the cotton plant should be exceptional in this connection. In any case, there appears to be no justification for the statement frequently met with that the cultivation of cotton as a ratoon crop was discontinued owing to the inferiority of the lint.

A small preliminary experiment with second-year plants of the Sakellaridis variety was carried out in 1923, and more detailed trials are now in progress. The results of this experiment seem to indicate that (1) ratooned plants in the second year give a higher yield than the first-year plants; (2) the quality of the second year's crop is by no means inferior to that produced in the first year; (3) the crop matures much earlier in the second year than in the first; (4) the loss from boll-worm attack is less in the second year than in the first; and (5) the number of bolls shed in proportion to the flowers produced is less in the second year.

Iraq.—Investigations to determine the variety of cotton best suited for cultivation in Iraq were commenced in that country in 1918, and the results of the work carried out between 1918 and 1920 have been summarised in this BULLETIN (1920, **18**, 73; 1921, **19**, 227). The work was at first conducted at Karradah, a suburb of Bagdad, and a a number of out-stations, but since 1921 it has been restricted to the Agricultural Research Station at Rustam, on the right bank of the River Dialah, about nine miles east of Bagdad. Information on the trials made at this Station is given in "A Report on a Varietal Test with Cotton on the Government Experimental Station, Baghdad, in 1922," by Roger Thomas, B.Sc., and Kalidas Sawhney, M.Sc., which has been published by the Empire Cotton Growing Corporation as *Memoir No.* 8, *Dept. Agric., Iraq* (1924), and deals particularly with the experiments carried out in 1922. Sixteen varieties were grown in that year, fifteen of which were of the *G. hirsutum* type, and the remaining one of the *G. herbaceum* type. The following are the principal results obtained.

For the successful cultivation of cotton at Rustam, regular irrigation is necessary and must be provided at definite times, according to programme. If the soil is of satisfactory composition, and the crop is properly treated in its early stages, then with irrigation at intervals of 9–10 days during July and August a heavy yield can be obtained.

Under the conditions prevailing at Rustam in 1922, cotton plants of the *G. hirsutum* (American) type had two distinct periods of reproduction. The first period extended from the middle of July to the end of August, and the second, during which between 60 and 70 per cent. of the total crop was harvested, from the beginning of October to the middle of December. Local cotton (*G. herbaceum*) continued to yield fairly regularly throughout the season.

The best yields of seed-cotton were given by the varieties Cawnpore 9, Rustam 20, Rustam 47, Sudan and Rustam 48. On the basis of average yield of cotton multiplied by the valuation for the particular variety, Rustam 20 takes the first place, and is closely followed by Cawnpore 9. Both these varieties are composed of mixed types, owing to cross-fertilisation; they are relatively late in maturing and give a cotton of short staple. They are not suitable for distribution to cultivators at the present stage.

The variety Webber 49–3 appears to be a slight improvement on the original Webber 49 (see this BULLETIN, 1921, **19**, 227), and is a desirable form to propagate on account of its relative early maturing habit, its fairly high yield and satisfactory ginning percentage, and the comparatively high value of the cotton. About 2,000 acres of this variety were planted in 1923, with a view to its cultivation by growers to the exclusion of all other varieties in 1924.

Careful analysis of the yield records has shown that the heaviest yields of seed-cotton are generally given by tall plants which develop three or four vegetative branches, and a profusion of long, slender flowering branches with moderately short internodes. The Webber type does not possess these features to the desired degree, and it is, therefore, hoped that it may be possible by artificial crossing to evolve a strain combining the lint characters of the Webber type with the plant habit of the Indo-American varieties. Experiments in this direction have already given promising results.

Nigeria.—During the last twenty years, persistent attempts have been made to introduce American cottons into the Oyo and Abeokuta Provinces of Southern Nigeria, but without success. This failure is particularly striking when contrasted with the favourable results which have attended the introduction of American cotton into the Northern Provinces of Nigeria. In order to ascertain the nature of the causes which inhibit the development of the American plant while permitting that of the native kinds, a study has been carried out by the Agricultural Department of Nigeria, and the results so far obtained have been published in a paper, by T. G. Mason, M.A., Sc.D., Agr.B., and G. H. Jones, B.A., entitled " A First Survey of Factors Inhibiting the Development of the Cotton Plant in Southern Nigeria," on pages 11–30 of the *Third Annual Bulletin of the Agric. Dept., Nigeria* (1924).

It is shown that the direct effects of rainfall or of drought are inadequate to account for the differences in the behaviour of the American and native cottons, and that factors, other than climatic, must be responsible for the comparative failure of the American kinds.

The American cotton plant (Allen's Long Staple) is much more readily attacked by insect pests than the native plant, and this is probably the chief reason for the lack of success with the former. Moreover, considerable significance is attached to the fact that some of the insects introduce fungal and possibly bacterial diseases. The marked variation in the yields of American cotton from year to year may be due to a variability in the insect population, and this, in turn, is determined by variations in the August rainfall.

The native cotton (*G. peruvianum*) of the Southern Provinces, Nigeria, is sometimes affected by a peculiar condition which is characterised by the recession of chlorophyll from the margin of the leaf and an irregular crinkling or puckering of the lamina. This affection, for which the name " crinkle " is proposed, was particularly prevalent on the Moor Plantation of the Agricultural Department during the 1923–24 season. It first became noticeable at about the end of the rainy season, and was especially marked on the newly-formed leaves. An investigation has been carried out with the object of determining whether the malady is dependent on the character of the soil or is due to some other factor. The results of the work are given in a paper by C. H. Wright, M.A., F.I.C., and T. G. Mason, M.A., Sc.D., Agr.B., entitled " Concerning Correlations between Certain Soil Moisture Constants and Crinkle of the Cotton Plant," which is published on pages 31–40 of the *Third Annual Bulletin of the Agric. Dept., Nigeria* (1924).

A correlation has been found between the crinkle of the plant and the hygroscopic coefficients of the sub-soils, which is considered to favour the view that the condition possibly owes its origin to the inability of the sub-soil to supply moisture at a sufficient rate for the normal functioning of the leaves.

No relation could be traced between the diameter of the cotton fibre and any of the soil characters, but a low correlation is suggested between the length of the fibre and the water-holding capacity of the soil.

Flax

Canada.—An account of flax experiments carried out in Canada in 1923 is given in the *Report of the Chief Officer, Division of Economic Fibre Production, Department of Agriculture, Canada, for the year* 1923. The following are some of the results recorded. Trials to determine the best quantity of seed to sow have indicated that the yield of fibre increases with the rate of seeding up to 110 lb. or 1·95 bushels per acre. The experiment was not carried far enough to determine the quantity which produces the optimum yield per acre, but it showed that 1½ bushels per acre (the amount usually sown in Ontario) does not give the greatest possible yield of fibre.

Hitherto flax and hemp have been prepared in Canada either by dew-retting or pond-retting. Tests have now been made of retting by the Kayser process, which involves the addition of a bacterial culture to the retting water and the maintenance of the water at about 77° F. An account of this process has been given in this BULLETIN (1922, **20**, 363). The fibre obtained in the experiments was very green and of a harsh nature which is not favoured by spinners; it had an average breaking strength of 1·5 kilos.

Scutching trials with the Boby machine (described in this BULLETIN, 1922, **20**, 212) gave very good results. The machine is regarded as superior to the scutching system previously employed, as it leaves the fibre more open; it is recommended for use by growers of small areas of flax, of which there are many in Quebec and the Maritime Provinces.

Kenya.—In the *Ann. Rep. Dept. Agric., Colony and Protectorate of Kenya*, for the year ended December 31, 1923, reference is made to the flax industry. The acreage devoted to the crop has continued to decrease, and the areas harvested during 1920–1923 were as follows: 1920, 9,297 acres; 1921, 26,475 acres; 1922, 14,587 acres;

1923, 11,781 acres. The exports of flax from Kenya during the same years are given below:

Year.	Quantity. Cwts.	Value. £
1920	6,029	9,304
1921	8,818	13,221
1922	38,500	60,491
1923	21,270	44,861

The cultivation is now being restricted to those areas which are best adapted for it. The grading of the fibre is still being carried out by the Government (see this BULLETIN, 1922, **20**, 98) and the charges have been reduced to 30*s.* per ton for flax and 10*s.* per ton for tow. It is considered that this reduction should ensure that the whole of the flax produced in Kenya will be Government graded. In order to diminish the travelling expenses of the Flax Officer, it is suggested that the grading and baling for export should be centralised at Nakuru. This would enable the grader to deal with three times as much flax as is possible under the present itinerant system. In addition to grading, the Flax Officer gives advice to planters and conducts experimental work in the various areas. Particulars of his activities are given in the Report.

The flax season of 1923 was the best experienced in Kenya for several years, but considerable losses were occasioned by the attack of caterpillars and by wilt disease, especially in the Njoro district. During that year, three new flax mills were erected in the Molo and Gilgil districts, and were equipped with machinery purchased locally from districts which have been found unsuitable for flax production.

South Africa.—With a view to the definite establishment of flax production in South Africa, a thorough investigation of the industry has been made by Mr. E. Baker, B.Sc., Botanist, Elsenburg School of Agriculture, who in 1924 made a visit to Europe for the purpose. His report has been published in two parts, entitled respectively, " The Possibility of Creating a Flax Industry in South Africa " and " Flax Factory Management," which have appeared in the February and March issues of *J. Dept. Agric., Union of S. Africa* (1925, **10**, 110, 234).

A detailed review of the whole subject of flax production is given in these papers, from which the following notes, relating particularly to the possibilities in South Africa, have been drawn.

Trials which have already been made in the Union show that flax can be grown in some parts of the country with the production of good yields of both linseed and straw. It has also been observed that even when the seed has been allowed to ripen the straw is still capable of yielding good fibre. It is, therefore, considered feasible to produce both seed and fibre in South Africa from the same crop.

Samples of flax prepared in Germany from straw grown in South Africa in 1922 were submitted to spinners and buyers in Ireland and Belgium and were valued at £140–£170 per ton, when the best Belgian flax was quoted at £180 per ton.

In view of the world shortage of flax, owing chiefly to diminished production in Russia, there appears to be a good opportunity for South Africa to become a flax-producing country. It is necessary, however, to consider whether linseed and flax could be produced in sufficient quantities to compete satisfactorily in the world's markets.

It has been found in South Africa that the best wheat lands—the heavier types of soil—have produced the best flax and that light, sandy soils are unsuitable for the crop. The chief difficulty arises from the unevenness in fertility of the soils, which leads to a lack of uniformity in the crop, the straw varying considerably both in length and diameter. It would, therefore, be necessary to practise some system of rotation to ensure a more uniform condition of the soil in respect of both tilth and fertility.

It is suggested that, at first, the farmer should deliver the whole crop of straw, including the seed, to a central factory, as it is essential that the factory should have control of the seed in order to ensure that the farmer should receive the right type for sowing.

Experiments which have been carried out with South African straw at the Schlesische Flachs-Werke at Kaundorf, Silesia, have shown that of various retting processes that best suited to South Africa would probably be some modification of the warm-water system.

It is considered that with flax prices at their present level, it should be possible for a profit to be made of 20 per cent. on the capital invested, and it is suggested that if farmers were encouraged to grow the crop and the best strains of seed were introduced and developed, a useful and profitable industry could be established.

The second part of the report describes various methods of retting, drying, breaking, scutching, sorting and grading, and the installation of a flax factory. It is well illustrated with reproductions of photographs taken by Mr. Baker during his tour in Europe. Particulars are also given regarding costs of production. The report will be of great value and assistance if the development of a flax-growing industry in South Africa is seriously undertaken.

Hemp

Canada.—Increasing interest is being evinced in the Canadian hemp industry, owing partly to the uncertainty of the supply of binder twine for harvesting, and partly to the high prices now ruling for hemp due to the diminished quantity obtainable from Russia. In view of the numerous enquiries received on this subject, the Division of Economic Fibre Production of the Department of Agriculture have carried out experiments with the crop which are recorded in the *Report of the Chief Officer*, for the year 1923 (Ottawa, 1924). The results have indicated that when soil conditions are favourable for hemp cultivation the fibre can be grown very profitably at the present prices.

Jute

India.—In Eastern Bengal and Assam, the jute plant is sometimes attacked by a stem rot. The disease generally attacks the stem near the ground level, and in the early stages produces a pale reddish-brown discolouration, which gradually darkens and extends until the whole stem withers. Sporadic cases of this stem rot are of common occurrence, but it only becomes epidemic under certain conditions of cultivation. The disease attacks both *Corchorus capsularis* and *C. olitorius* at all stages of growth. On the more mature plants, the mycelial growth is accompanied by the copious formation of small black sclerotia in the interior of the stem among the bast fibres, and by the development of pycnidia which appear as small black dots just beneath the cuticle.

A study of the disease has been carried out by F. J. F. Shaw, D.Sc., A.R.C.S., Second Imperial Mycologist, and the results have been published in *Mem. Dept. Agric. India* (*Bot. Ser.*, 1924, **13**, No. 6).

The fungus has been identified as *Macrophoma Corchori*, recently described by Sawada as a jute parasite in Japan. Inoculation experiments have shown that the pycnidial and sclerotial forms belong to the same fungus. The pycnidium occurs only on the jute plant, and has never been obtained in artificial culture. The sclerotial form occurs in artificial culture on jute, cotton, potato and other host plants. Cultures isolated from jute, cotton or potato give rise to the pycnidial form when infected on jute.

Sawada found that the incidence of the disease could be reduced by the application of potash to the soil, and the same result was obtained independently by Finlow on the jute plants of the Dacca Farm. As the field experiments at Dacca indicated that the heaviest growth of jute is obtained when the potash in the soil is in excess of that normally required by other crops, it seems probable that a slight deficiency of potash in the soil would depress the vitality of the jute plant much more than it would affect the metabolism of the fungus, which is also living in the soil, and so render the jute more liable to attack.

Manila Hemp

According to the *Ann. Rep. Bur. Agric., Philippine Islands, for the year ended Dec.* 31, 1923, the production of Manila hemp in 1923 was 2,986,380 piculs (about 189,000 metric tons) which is the largest yet recorded. The area planted with the crop amounted to 513,421 hectares, and the productive area to 344,240 hectares.

A study of the causes of the deterioration of the fibre has been carried out, and a number of bacterial diseases and species of fungi have been isolated from defective samples. Information obtained from producers and dealers indicated that defective fibre is found only among the lower grades, such as " J," " L," and " M," and only occurs in bales which have been stored for five months or more. These opinions have been confirmed by investigation, both in the laboratory and outside. It has now been proved conclusively that the deterioration is due to *Aspergillus niger* and another species of Aspergillus, and a sterile fungus.

The damage can be minimised by (1) proper drying of the fibre before it is deposited in the warehouse, (2) proper ventilation in the warehouse, (3) avoiding too long storage in the warehouse, particularly in the case of the lower grades, and (4) ceasing the production of low grades.

It will be observed that the views advanced by the Imperial Institute, as the result of an investigation of some defective Manila hemp undertaken on behalf of Messrs. Wigglesworth & Co. (this BULLETIN, 1921, **19**, 127), are thus fully corroborated.

Paper-making Materials

Tambookie Grass.—A number of South African tambookie grasses have been examined at the Imperial Institute as materials for paper-making and the results have been recorded in this BULLETIN (1916, **14**, 163; 1918, **16**, 127; 1919, **17**, 141).

An account of experiments with the tambookie grass known as *Hyparrhenia glauca*, Stent, by E. F. English, M.Sc., Chemical Engineer, Department of Mines and Industries, South Africa, has appeared in the *S.A. Journ. Indust.* (1924, **7**, 745). The grass was digested with caustic soda under pressures of from 30 to 90 lb. per sq. in. for periods of from 3½ to 5 hours. The amount of caustic soda employed varied from 14 to 25 per cent. of the weight of the bone-dry grass and the concentration of the solution from 10 to 29 grams of caustic soda per litre. The results showed that under the best conditions a yield was obtained of 46–47 per cent. of bone-dry pulp (expressed on the bone-dry grass). The pulp was of a pale colour and could be bleached with less than 10 per cent. of bleaching powder. It consisted of fibres of an average length of 1·5 mm., had good felting properties, and furnished strong paper. It is suggested that the pulp would be of great value for mixing with short-fibred pulps from South African woods.

The flowering tops of the grass, when digested with 21 per cent. of caustic soda for 4 hours under 70 lb. pressure, gave a yield of 37·8 per cent. of pulp which was of very dark colour and could not be bleached. It is, therefore, considered that this part of the grass should not be used for paper-making, but should be discarded in the fields.

MINERALS

Coal

Nigeria.—*Bulletin* 6, *Geological Survey, Nigeria*, 1924, describing the Enugu area of the Nigeria coalfield, has already been referred to in this BULLETIN (1924, **22**, 232). *Bulletin* 8, by R. C. Wilson, on the geology of the Eastern Railway from Port Harcourt to Enugu, which has appeared recently (1925), contains a description of the Cretaceous coal measures of the Enugu, Udi and Omuma areas.

A tributary of the Olawba (Enugu area) exposes four seams of coal. The lowest (No. 2), 18 in. thick, is separated by 13 ft. of shale from the No. 3 coal, 5 ft. thick, which is divided into two equal portions by 8 in. of hard shale. The No. 4 and No. 5 coals above are 8 in. and 18 in. thick respectively. (In the River Obokwa, of the same area, the No. 3 seam has 5 ft. 5 in. thickness of solid coal.)

In the River Nveni (Udi area) there are 29 ft. of measures (sandstone and shale) between the two portions of No. 3 coal, the lower portion being only 8 in., and the upper portion 2 ft. thick. In the River Ofam (Udi area), in which the coal was first discovered, there are five exposures of coal. The lowest seam (No. 2) is 2 ft. 3 in. thick. The No. 3 seam is divided into two portions by 7 ft. of shale and sandstone, the lower and upper portions being 2 ft. 2 in. and 3 ft. thick respectively. The No. 4 seam is only 6 in. thick. In the River Lyuwaneke (Udi area), farther south, the No. 2 seam is 13 in. thick, and the No. 3 seam is divided by 13 ft. of measures, the lower and upper portions being 2 ft. 1 in. and 1 ft. 10 in. thick, respectively.

In the River Omuma (Southern area) the No. 3 coal is at least 4 ft., and the No. 4, 2 ft. 6 in. thick.

The various coal seams in the Udi area can easily be correlated with each other, as can the seams in the Enugu area. The correlation of the seams in the one area with those in the other is, however, purely tentative, and is based on facts observed in the field. It is interesting to note the similarity of the sequence in the River Omuma to that at Enugu, and when that part of the country is investigated more fully a definite correlation of the seams may be possible.

Australia.—A report by L. F. Harper on the coal resources of the Douglas Park Area, New South Wales, has appeared recently (*N.S.W. Dept. Mines, Geol. Survey, Mineral Resources*, No. 32, 1924).

The No. 1 or Bulli seam of the Southern (Permo-Carboniferous) coal-field is referred to in the Imperial Institute Monograph *Coal* (1920, p. 110). The Douglas Park bore, which reached the Bulli seam on December 14, 1922, at a depth of 1,688 ft., proved it to be nearly 9 ft. thick. An average sample was analysed and gave the following percentages: hygroscopic moisture, 0·64; volatile matter, 25·05; fixed carbon, 65·92; and ash, 8·39. Coke, 74·31 per cent. The calorific value was 12,764 B.T.U. Another bore put down about two miles north of the last one in 1923 reached the Bulli seam at a depth of about 1,795 ft., and proved 8¾ ft. of clean coal, the calorific value of which was the same as that of the Douglas Park bore. In the light of present evidence it appears more than likely that an area of approximately 160 sq. miles of workable coal occurs between Bargo on the south, and Campbelltown on the north, extending in an E.-W. direction from Appin to Picton. Assuming that a thickness of 6 ft. only occurs over the whole area (14,000 acres), and that 1,200 tons of coal are recoverable per acre-foot, then the coal reserves within this triangle, actually proved by boring, are likely to exceed 100 million tons. In all probability the workable coal extends for some miles in each direction beyond this area prospected by boring, and the actual tonnage may exceed 250 millions.

The importance of this area to New South Wales, as regards its coal resources, cannot be over-estimated. It should add many millions of tons to the State's reserves. There appears no reason why an important coal-field should not be developed within 40 miles of Sydney, and in addition to export possibilities, the winning of coal in this area promises cheaper coal for the whole of the Southern Railway system and favourable conditions for the extension of manufacturing interests beyond the confines of the metropolitan area and yet convenient to it.

The Bowen River coal-field, Queensland, is briefly described in the Imperial Institute Monograph *Coal* (1920, p. 121). Parts I and II of J. H. Reid's geological survey report on the field have now appeared (*Queensland Govt. Min. Journ.*, Nov. and Dec., 1924, pp. 399 and 447).

R. M. Jack reported on the Bowen River coal-field forty-six years ago, and the coal seams with their vast tonnage have remained practically untouched until the last few years. At present, two collieries—the State and the Bowen Consolidated—are in active operation, with an increasing output. The town of Collinsville, which has sprung up around the State Colliery, has been linked up by rail with the town of Bowen, fifty-three miles to the north-west.

The coal occurs in the Collinsville coal measures of the lower Middle Bowen Series (Permo-Carboniferous), the upper group being the Marine Series. The measures probably underlie the entire coal-field, which has an area of about 1,700 sq. miles. The important seams, in descending order, are the Garrick, Scott, Denison, Potts, Bowen and Blake. The present output is entirely produced by the Bowen and Garrick seams. The known coal-bearing area, more or less proved by 26 bores to a maximum depth of 800 ft., comprises about 20 sq. miles. The Blake is the lowest seam reached by the bores, and is also the thickest. In No. 24 bore it contains 23 ft. 8 in. of coal, 12 ft. of which is described as of fair quality. The eastern portion, near Collinsville, varies from 6 ft. 3 in. to 11 ft. in thickness. The Bowen seam has a maximum thickness of 19 ft. 7 in. in No. 30 bore and a minimum of 10 ft. 9 in. in No. 19 bore. The Potts seam is small, varying from a few inches to 9 ft. thick. It contains workable areas of coal. The Denison seam, although preserving a uniformly workable thickness in all the bores, has suffered deterioration as the result of intrusions of igneous rock. The thickness varies from 3 ft. 6 in. to 8 ft. The Scott seam, which lies from 200 to 245 ft. below the horizon of the Garrick seam, is destroyed or badly affected by intrusions in places, but, east of No. 18 bore, has an average thickness of 5 ft. 3 in. The Garrick seam, ranking next in economical importance to the Bowen seam, east of No. 5 bore, averages 7 ft. in thickness. The coal is usually soft and pliable, and on stacking has a tendency to form slack and to generate spontaneous combustion. On the western portion of the drilled area the seam is either entirely destroyed by sills or badly split by bands.

From any estimate as to the tonnage of coal likely to be available for mining, large deductions must be made for coal destroyed or affected by intrusive rocks.

The following is an estimate of the coal reserves :

Estimate of Coal Reserves in the Defined Collinsville Area

(Within an approximate area of 20 sq. miles)

Seam.	Total Tonnage.	Probable Available Tonnage.
Garrick	48,300,000	13,800,000
Scott	67,460,000	17,700,000
Denison	62,560,000	19,120,000
Potts	17,040,000	5,500,000
Bowen	136,700,000	40,760,000
Blake	87,680,000	13,660,000[1]
Totals . . .	419,740,000	110,540,000

[1] *Probably understated ; data incomplete as to tonnage likely to be affected by intrusions. Coal in this seam probably too inferior for present-day operations.*

The Lower Bowen Coal Measures are about 400 ft. thick, but are not likely to be productive. The Upper Bowen Coal Measures are estimated to be 9,000 ft. thick, and consist of fresh-water sediments, except for one marine horizon localised to the Havilak district. They cover 800 sq. miles, but the extent and importance of the coal seams in these measures is unknown ; they appear to have a wide distribution, and to be on a number of distinct horizons. The coal is bituminous and has a close approximation in composition to that of the seams of the Collinsville Measures.

The Wilga coalfield of Western Australia is a few miles south of the Collie field described in the Imperial Institute Monograph *Coal* (1920, pp. 141–143). According to the *Report of the Department of Mines, Western Australia*, for 1921, the first two coal seams were struck in 1918 in O'Grady's discovery shaft at depths of 55 and 85 ft., and proved to be 5 ft. and 4 ft. thick, respectively. Three deep bores, put down and completed in 1921, intersected a number of coal seams. No. 1 deep bore struck 6 seams in a depth of 186 ft., the best being 5 ft. thick at a depth of 87 ft. The No. 2 bore pierced 13 seams in a depth of 426 ft., four of which were from 5 to 9 ft. thick. No. 3 bore cut 11 seams in a depth of 347 ft., four of which were from 5 to 6¾ ft. thick. The calorific value of this coal varied from 7,583 to 9,913 B.T.U.

In the *Report of the Department of Mines for* 1923, recently published, it is stated that No. 4 deep bore (60 chains N.W. of No. 3) cut 11 seams in a depth of 660 ft., the best being as follows:

No. of seam.	Depth from surface to top of seam.	Thickness.	Calorific Value in B.T.U.
4	500 ft.	10 ft. 6 in.	9552
5	537 ft.	4 ft.	9928
6	563 ft.	7 ft.	9195
7	573 ft.	5 ft.	9645
8	591 ft.	9 ft. 1 in	9625

Several hand bores put down have also disclosed seams from 3 in. to 7½ ft. thick. The Wilga Prospecting Co., whose holding includes O'Grady's discovery shaft, and Nos. 1 and 2 deep bores, have sunk two additional shafts. In one of these a seam 5½ ft. was pierced at a depth of 38 ft., which seems to correspond with the 5 ft. seam of the No. 1 bore. The calorific value was 10,406 B.T.U. A seam 7 ft. thick was struck in the other shaft at a depth of 45 ft., the calorific value being 9,981 B.T.U.

Wilga may be regarded as a southern extension of the Collie field—the area being probably 24 sq. miles. Most of the coal seam tested in 1921 proved to be just a little lower in calorific value than the best at Collie, although in two instances the value was higher than that of the general average of the Collie coals. The calorific value of four of the best seams cut in the No. 4 deep bore is above the general average of that of the Collie coal (viz. 9,407 B.T.U.), and only one (No. 6) is below that average.

Copper

Canada.—According to J. F. Wright, of the Canadian Geological Survey (*Canadian Official Mining News Letter*, No. 50), in the Oiseau copper area, which is thirty miles south of the gold area of S.E. Manitoba (see p. 231), extensive exploration was undertaken in 1924 on the Wento and Cup Anderson copper deposits. The results were so encouraging that the two deposits are now being explored by shallow diamond drill holes. Some ten other occurrences of copper-bearing minerals are known in the area, but little prospecting has been completed on any of them, with the exception of the Chance-Devlin copper-nickel deposits.

Belgian Congo.—The copper deposits of Katanga, Belgian Congo, are described in the Imperial Institute Monograph *Copper Ores* (1923, p. 139). The following information dealing with recent developments is taken from an article by Owen Letcher (*Eng. and Min. Journ.-Press*, Feb. 14, 1925, p. 277).

The Star of the Congo mine has been opened up for more than a mile from N.W. to S.E. The deposit is vertical and about 200 ft. in width. At Ruashi, near this mine, the ore-body is 60 ft. wide and flat. It has been opened up during the past three years, and is now contributing a large tonnage of high-grade ore to the smelters.

In the Luishia mine, fifty miles N.W. of Elisabethville, sulphide ore, as proved by boring, occurs at a depth of about 700 ft.

In the Likasi mine, 80 miles N.W. of Elisabethville, the ore-body dips W. 40°, and is cut off by faulting in depth. It has produced 500,000 tons of 12 per cent. ore. At the Chituru mine, near the Likasi, the ore carries 8 per cent. of copper, and is being leached.

In the Kambove mine, 85 miles north of Elisabethville. the ore-body runs E.–W. and dips N. at a flat angle, It is about 2,300 ft. long, and has an average width of 328 ft. The ground in depth is cut off by faulting. Since 1914 this mine has produced 3 million tons of ore. At present (Feb. 1925) the smelting ore carries 16½, the concentrating ore, 8 to 9, and the leaching ore 6·7 per cent. of copper.

For smelting the copper ores, coke from the Wankie Colliery, Southern Rhodesia, is used. Coal was discovered not long ago near Sankishia, 170 miles north of the Lubumbashi smelter. Extensive prospecting has disclosed 20 million tons of coal here, and one colliery, the Luena, has already been opened up. The coal is said to have a very "shaley" appearance, and to be high in ash. A large pulverising plant is practically completed at Lubumbashi for treating this coal. The extraction of copper at Lubumbashi is said to be 77 per cent. Blister copper of 97½ per cent. purity is being produced. It is intended in the future to refine the copper at the plant.

There is a concentrating plant at Panda, 65 miles N.W. of Elisabethville, having a capacity of 4,000 tons per day; also a small leaching plant, but it may be some years before the big projected leaching plant is constructed. The tailing from the concentrating plant contains from 5 to 6 per cent. of copper, which is stored for subsequent flotation treatment.

From 1922 to 1924, the production has been 43,362, 57,886, and 85,700 tons of copper.

The total ore reserves at the end of 1923 were estimated at 73 million tons containing 4,802,000 tons of copper.

United States.—The Magma copper mine, in the Superior district, Pinal Co., Arizona, is described by W. C. Browning and F. W. Snow (*Eng. and Min. Journ.-Press*, Jan. 31, 1925, p. 197). The principal workings are in Devonian limestone, Upper Cambrian quartzite, and a sill of diabase (dolerite). The ore-bodies occur as shoots in a strong fault-fissure with an E.–W. strike, or nearly perpendicular to the bedding-planes which dip E. 30°–35°. There is an altered porphyry intrusion in the vein, which is assumed to be a quartz-diorite. The Magma ore-bodies are of value chiefly for the copper, silver and gold contents. Blende of good grade also occurs, and may some day be of considerable commercial importance. Oxidised ore occurs to a depth of about 900 ft., and consists of malachite, chrysocolla, some chalcocite, and, in places, cuprite. The chief mineral in this zone of secondary enrichment is chalcocite with some bornite and pyrite. The primary ores are principally bornite, chalcopyrite and pyrite. In the deeper levels some tetrahedrite and primary chalcocite are found. In the secondary zone there is usually 1 oz. of silver per ton, and in the primary zone, 0·6 oz. of silver per ton to each 1 per cent. of copper. The gold in both zones averages in value from 50 to 75 cents per ton. A high percentage of ore has been mined from one large central ore-shoot, which, in the lower levels, is from 1,200 to 1,500 ft. long, and of average width 20 ft.

The width has increased considerably in the lower levels. On the deepest developed level—2,000 ft.—the ore has an average content of more than 6 per cent. of copper. The bornite and chalcocite found between the 1,700 and 2,000-foot levels seem to be much more massive than in the levels above.

Gold

Canada.—Mining developments in Northern Manitoba have already been described in this BULLETIN (1920, **18**, 93). Recent developments in the S.E. Manitoba mineral belt are described by J. F. Wright of the Canadian

Geological Survey (*Canadian Official Mining News Letter*, No. 50).

The mineral belt of S.E. Manitoba extends east from the south end of Lake Winnipeg to the Manitoba-Ontario boundary, and north from Winnipeg River to a few miles north of Wanipigow River. Within the area of about 2,500 sq. miles, prospecting in 1924 was active in the Rice Lake goldfield and in the Oiseau copper area (see p. 228).

In the gold area, at Selkirk mine, the ore-body has been driven on at several levels down to a depth of 525 ft. The Hope-Kitchener break or fracture zone has been traced for about two miles along the strike. Near the west end, commercial ore is reported to occur at surface for 1,000 ft. along the strike and across a width of 2 to 12 ft. Another ore lens, about 600 ft. long and from 3 to 15 ft. wide, is known about 1,500 ft. farther east along the strike. Preparations are being made to diamond drill the vein and to begin the sinking of a shaft.

Extensive surface stripping and sampling were completed on the Ora Grande vein, 5 miles S.E. of the last-mentioned property. The ore lenses are small, but of exceptionally high grade.

In 1924 three new discoveries of free gold were made, and considerable stripping and sampling were completed on numerous veins in this area, other than those already mentioned.

The newly-discovered gold-bearing belt of N.W. Quebec has already been referred to in this BULLETIN (1923, **21**, 535 ; 1924, **22**, 88 and 372 ; 1925, **23**, 92.)

A report on these gold-fields by W. B. Timm and A. H. A. Robinson has appeared recently (*Dept. Mines, Canada, Mines Branch Investigations, Memorandum Series*, No. 20, Feb. 1925) from which the following notes have been taken.

Metallurgically the ores may be divided into :

(1) Ores consisting chiefly of chalcopyrite and pyrrhotite ; *e.g.* the Horne (Rouyn Township) and the Stabell (Dubuisson Township). These ores would be amenable to pyritic or semi-pyritic smelting. The disseminated ore would first have to be concentrated.

(2) Ores in which pyrite is abundant, e.g. Arntfield and Lake Fortune (Boischatel Township), and the Chadbourne claim (Rouyn Township). Such ores can be treated by cyanide, any copper present being first removed by concentration.

(3) Ores in which arsenopyrite and pyrite predominate, the country rock being described as conglomerate intruded

by masses of porphyry ; *e.g.* Edna Bathurst claim (Rouyn Township) and O'Brien claims (Cadillac Township). These ores could be concentrated and then treated by cyanide ; the arsenical concentrate might be refined locally.

At the present time the Mines Branch, Department of Mines, Ottawa, is experimenting in a small way on possible methods of treatment of these ores other than those of established practice.

On the Horne mine some 14,000 ft. had been diamond drilled by the end of 1924, proving the continuity of the deposits to a depth of 250 ft. One hole down over 450 ft. still showed heavy mineralisation. The reported figures for values of ore reserves, based on drilling only, assuming the value per ton to be \$6·50, runs into tens of millions of dollars. Two development shafts were started in 1924. Shaft No. 1, near the southern boundary of the claim, was sunk to a depth of 120 ft., for the most part in practically solid sulphides. The ore is stated to have averaged over 15 per cent. of copper, and \$6·50 value per ton in gold. The ore from No. 2 shaft, started in October, 1924, contains more pyrrhotite and less chalcopyrite than the ore of No. 1 shaft. The two shafts, which are 1,100 ft. apart, will eventually be connected at the 110-foot level. The erection of a smelter is under consideration.

In the Stabell mine a vertical shaft has been sunk to a depth of 600 ft. The quartz vein, which dips 75° in Keewatin basalt, closely follows a porphyry dyke about 8 ft. wide. The vein, which carries chalcopyrite and pyrrhotite, has been explored for a length of 650 ft. at the 300-foot level, and is being developed on the 600-foot level.

Much exploration work has been carried out, and development by shaft sinking is in progress on various claims or groups of claims in Joanne, Clericy and Fourniere townships. In all these claims pyrite is the predominating sulphide in the ore.

Australia.—The Youanmi gold-mining centre, in the Black Range District of the East Murchison Goldfield, Western Australia, is described by F. R. Feldtmann (*Rep. Dept. Mines, Western Australia,* for 1923, p. 100).

This centre is in the northern portion, and close to the eastern margin of an extensive greenstone belt, probably more than twenty miles in length, and enclosed by granite of relatively later age. This granite throws numerous tongues or dykes into the greenstones, which consist of epidiorites, gabbros and amphibolites. The first of these rocks are correlated with the younger greenstones of Kalgoorlie ; the last two belong to still later series. There are also post-gold dykes of fine-grained basaltic epidiorites.

The jaspers strike N.N.W. to N.E., and occupy zones of intense shearing, which took place immediately subsequent to the granite intrusion. In depth these shear zones are represented by magnetite bodies.

The great cross reefs and shear zones form one of the most important features of the area. They represent immense normal faults, which cut the boundary between the granite and the greenstones. The larger faults are wide shear zones up to 60 ft. in width. Numerous smaller cross-faults occur, and also complementary fissures now partly filled by quartz veins, at right angles to them, as well as nearly diagonal fissures. This series is younger than the jaspers and older than the lodes.

Subsequent to ore deposition, there has been intense shearing, which took place at several periods. One series, approximately parallel to the lodes, has seriously affected the continuity of the ore shoots.

The lodes represent zones of intense shearing altered by mineralising solutions. The ore-bodies of the Youanmi mine are characterised by the presence of stibnite, as well as, in the main lode, arsenopyrite in large quantities. The presence of these sulphides has greatly increased the difficulty and cost of treatment. The payable lodes so far discovered are those of the Youanmi mine and of the United and Hill End leases to the north. The main lode of the Youanmi mine has been proved for a length of about 900 ft., and to a depth of 778 ft. The average dip is 58°, and the average width about 4½ ft. The *P* Shaft lode has been worked over a length of 650 ft. at the surface, and for 900 ft. at the 91-ft. level, but the lode was by no means continuous over that length, the ore shoots being much broken up by shear zones and granite dykes. At the 193- and 294-foot levels the lode was driven on for 420 and 285 ft. respectively. A large granite dyke was cut in both these levels.

Two lodes have been worked in the United and Hill End leases, but very little below water-level. The lode at surface averages 4 ft. in width.

A few small auriferous quartz reefs occur in and east of the Golden Crown group. These reefs contained some rich patches.

The Paynesville gold-mining centre, Murchison Goldfield, Western Australia, is described by Feldtmann (*op. cit.* p. 104).

The main country rock is greenstone in the form of massive epidiorite from gabbro or quartz-dolerite. It forms a belt possibly 47 miles long and 20 miles wide. A number of large dykes of quartz-porphyry intrude the greenstone. There are also small dykes of fine-grained epidiorite, probably post-gold.

The greenstone rocks are cut by a number of "bars" or lenses of jasper. Quartz reefs of no great length, and ranging from a thread to about 5 ft. in width, occur both in the greenstone and in the porphyry. The reefs carrying payable gold are confined to the greenstones, but are usually in close proximity to the porphyry dykes. In the greenstones the auriferous reefs occur as comparatively short lenses along narrow zones of intense shearing in which the epidiorites have been altered to hornblende- or chlorite-schist. Some of the reefs are heavily pyritised. The gold content is patchy and many of the reefs have proved unpayable.

The wider portion of the Elsie lease (2 to 5 ft.) was exceptionally rich, and up to April 1924, had produced 461 fine oz. of gold, of which 102 fine oz. was from a quarter of a ton of ore, and the remainder from specimens. Owing to the erratic gold content of the reefs, and their comparatively short lengths, they are not suitable for large companies, but the richer reefs should prove highly remunerative to small parties.

According to A. G. D. Esson (*op. cit.*, p. 109), the gold production of Paynesville to the end of 1922 was 5,004 oz.

The deep lead at Waverley or Siberia, Western Australia, is described by C. O. G. Larcombe (*op. cit.*, p. 113). There are shallow alluvial deposits in the same area occupying flat gullies and depressions on the hill-sides, which are of eluvial origin; the gold contained in them has been brought in locally.

The deep alluvial deposit occupies a type of sunk-land or miniature rift valley or depression filled with material consisting of variegated clay, ironstone gravels, pug, etc. The so-called "wash" occurs along the bottom of this material, and contains nuggets where it fills shallow depressions in the decomposed bed-rock. Up to May, 1923, 22 oz. of gold had been won in the form of slugs and nuggets of pure gold or of quartz and gold, ranging from small pieces up to pieces weighing nearly 2 oz. One sample of the wash consisted of 60 per cent. or more of pale yellowish, somewhat puggy clay, full of minute pebbles of ironstone (redistributed laterite) about twice the size of a pin's head; some large pebbles of ironstone; a medium number of glassy transparent and evidently polished (æolian or wind-worn) quartz grains, and occasional distinctly water-worn pebbles of quartz large enough to cover a sixpence. Besides gold mechanically deposited, there are minute specks of gold impregnating the puggy clay and coating the minute ironstone pebbles in the wash surrounding the gold nuggets. This gold has been precipitated from solution and is of secondary origin.

The infilling of this sunk-land was largely brought about by dominant wind, with subordinate water action, under the desert-like conditions which prevailed in this region in past geological times. According to Larcombe, the ground requires further testing, and there is still a possibility of finding a gutter in a direction easterly from the Prospector's shaft sunk in the deep ground, where greater concentration of gold nuggets may have taken place, and, moreover, there is a possibility that shoots or lodes or reefs may eventually be found beneath the eluvial ground.

New Zealand.—P. G. Morgan's report on the geology and mines of the Waihi District, Hauraki Goldfield, New Zealand, has recently appeared (*Bull.* 26, *New Series, New Zealand Dept. Mines, Geol. Survey Branch*, 1924).

The lode-bearing rocks of the Waihi mines are flows of quartz-andesites belonging to the Kapanga Series (Miocene), which for some hundreds of feet below the present land-surface have been propylitised, silicified (near the lodes), and much weathered. The fissuring and shattering of the " country " brought about by faulting was a preliminary condition for the lode-formation. The known length of the Martha lode of the Waihi mine is 5,000 ft. ; the width, from 1 to 100 ft. ; the maximum length of the main ore-shoot, 1,450 ft., and the average length, 1,200 ft. ; the vertical dimensions 1,250 ft., and the average thickness 30 ft. The main constituent of the lodes is quartz, with some calcite, potash-felspar (valencianite), chlorite, etc., with pyrite, blende, galena, and a little chalcopyrite.

The gold occurs alloyed with silver as " electrum," is rarely visible, and is sometimes associated with native silver, argentite and ruby silver.

The Waihi district was re-surveyed by Morgan in 1921 and 1922, and some of his conclusions differ materially from those of J. M. Bell and Colin Fraser published some years ago (*Bull.* 15, 1912).

Among his conclusions it is stated that there is probably an enrichment of the lodes at an horizon somewhat lower than the levels being worked in March, 1923.

Morgan recommends lateral prospecting of all well-propylitised rock near the present workings of the Waihi and Grand Junction mines, especially the western and south-western portions of the former, and is of opinion that sinking to 2,000 ft., or perhaps more, is thoroughly justifiable. Since the ore-bearing quartz-andesites have a general dip to the S.E., there is a fair possibility that ore-bodies may exist in that direction at considerable depths from the present surface. New bodies of partly secondary ore may be found in depth, and new primary ore-shoots are distinctly possible.

United States.—The gold placers of the Ruby-Kuskokwim region, Alaska, are described by J. B. Merlie, Jr., and G. M. Harrington (*Bull.* 754, *U.S. Geol. Survey*, 1924, p. 88). Colours of gold may be found in the bottom of almost any valley throughout the slate and schist area, but it is only where there has been a considerable primary concentration or a local re-concentration that workable deposits occur.

Since 1915, a considerable production of gold has been made from Spruce Creek. The gravel is from 2 to 5 ft. thick, the gold occurring in it close to bedrock. Considerable mining has been carried on in Tamarack Creek. The bottom layer consists of 1 to 5 ft. of " soft " bedrock above the true bedrock. Above this is from 3 to 8 ft. of gravel, followed by the overburden. The gold lies in the upper foot of soft bedrock, and in the lower 3 ft. of gravel. Workable gravel extends for over two miles along Trail Creek, and much work has been done on Birch Creek.

On Poorman Creek there is a coarse gravel from 2 to 12 ft. thick; above that is fine sharp gravel (" chicken feed ") from 6 in. to 12 ft. thick, then overburden and ice lenses to the surface. The material is frozen to bedrock. The coarse gravel consists largely of boulders of vein quartz and rusty quartz breccia, or conglomerate with varying amounts of igneous rocks, quartzite, slate and chert. The concentrate contains pyrite (most common), pebbles of wood tin, barytes and a small amount of magnetite. Most of the gold lies close to the bedrock surface, but it may extend up into 2 or 3 ft. of gravel. Flat Creek has produced a considerable quantity of gold, with which pyrite, rounded grains of cassiterite, magnetite, and a little arsenopyrite are associated.

There are numerous other creeks in the district that contain auriferous gravels.

In the Innoko district, Candle Creek has been successfully dredged, and on Moore Creek, hydraulicking is used for stripping off the overburden, and also for moving the gravel. The gold appears to have come from quartz-monzonite.

In the Iditarod district, there are alluvial deposits of gravel in the present stream valleys, and residual deposits in which stream action has had little or no place. In Otter Creek, alluvial deposits are being mined. Mechanical scrapers are used on the bench claims, and a dredge of the bucket-elevator flume type, using distillate for fuel, is at work mining the gravel of the Creek. The gravel is frozen, but is prepared for the dredge by thawing. The concentrate contains cinnabar, arsenopyrite and scheelite. The gold comes from monzonite, which usually forms the bedrock.

In Flat Creek, the bench claims are worked by mechanical scrapers, and the creek gravel by a dredge. The gold from the former is coarser and of higher grade than that from the latter, which is known as "formation gold." The gold is derived from the monzonitic mass at the head of the creek.

Five of the residual and eluvial placers are at the head of Flat Creek, two at the head of Chicken Creek and three at the head of Happy Creek. The monzonitic bedrock, which is much sheared and mineralised, and cut by numerous quartz veinlets and iron-stained joint planes, is the source of these placer deposits. Most of the mining is by open cuts and hydraulicking. Much of the gold is very fine, but on some claims 10 per cent. of it is recovered by amalgamation on copper plates.

The total value of the gold and silver recovered to the end of 1922 from the Ruby-Kuskokwim region is $27,586,960.

Iron

Australia.—The iron ore deposits of the Tallering Range on the Yalgoo goldfield of Western Australia have been known for about 50 years. During 1923, they were examined by the Geological Survey, and the results published in *Rept. Dept. Mines, Western Australia*, for 1923, p. 96.

The deposits are a prominent feature of the Tallering Range, being of fine-grained sedimentary rocks, which have been silicified and highly charged in parts with iron. In some cases almost pure siliceous beds alternate with others mainly of iron mineral; all stages of gradation from one to the other can be seen.

The formation containing the deposits is probably Pre-Cambrian. The iron is present as hæmatite chiefly, and in some cases the ore contains about 70 per cent. of iron. For definite estimates of the ore available, further examination, including boring tests, would be necessary, but a rough estimate made some years ago placed the quantity at not less than 10 million tons.

The deposits can be mined cheaply, but the most important problem is transport of the ore. This involves a road journey of about 30 miles to a railway, from which it is not a great distance to the port of Geraldton.

Monazite

Tasmania.—A deposit of monazite sand, believed to be of considerable extent, is stated to have been located in the El Dumeral valley of the Stanley River in the Zeehan district (*Indust. Austr. and Min. Stand.*, 1924, **72**, 848). Analyses are said to have shown the mineral to be of high commercial value, and a syndicate has applied for a lease of 1,000 acres of the deposit.

Nickel

Union of South Africa.—The sulphide ore-bodies containing nickel and copper at Vlakfontein, in the Rustenburg district of the Transvaal, received brief mention in the Imperial Institute Monograph *Nickel Ores* (1923, p. 30). *Memoir* 21 (1924) *of the Geological Survey of the Union of South Africa* contains a full description of the nickel-copper ore deposits of this region and their geological associations by P. A. Wagner.

This publication covers the results of nearly a year's investigation, and adds considerably to what was previously known of these deposits. At the same time it is not yet possible to report definitely as to their commercial value or their vertical extent. Wagner states that the deposits are of exceptional scientific interest, and admirable examples of magmatic sulphide segregations " or, in other words, of masses of sulphide ore forming an integral and essential part of a body of igneous rock " ; he adds that they are also an example of magmatic differentiation on an almost unparalleled scale.

The primary nickel minerals of the deposit are pentlandite ; a mineral formerly described as maucherite, but believed by Wagner to be a variety of polydymite ; and another nickel-containing mineral not yet identified. The predominant sulphide associated with the nickel and copper minerals is pyrrhotite, but in many places this has been replaced by marcasite. The pseudomorphism of the marcasite after pyrrhotite is generally complete and patches of pentlandite and chalcopyrite originally present in the pyrrhotite are now enclosed in marcasite. The resemblance of the mineralisation of the Vlakfontein deposits to that of the Insizwa deposit and also to the Sudbury deposits extends to metals of the platinum group, but these are present only in minute quantities in the Vlakfontein ore.

The sulphides occur in three forms as follows:

1. *Disseminated* or *spotted* ore distributed more or less regularly through a base of bronzite and other silicates;
2. *Mottled* ore, in which crystals and grains of bronzite are uniformly disseminated through a base of coarsely crystalline sulphides;
3. *Massive* or *solid sulphide* ore as irregular patches and veins, consisting of a coarse granular aggregate, the individual crystals of which often attain considerable dimensions.

The chief constituents of three samples of the ore are shown below:

	1. *Per cent.*	2. *Per cent.*	3. *Per cent.*
Iron . . .	38·10	40·05	39·48
Nickel . . .	3·20	4·15	3·71
Copper . . .	0·55	0·80	0·48
Sulphur . . .	24·50	28·00	26·06

The ore zone is not continuous: the deposits take the form of completely isolated masses composed of all three kinds of ore, the disseminated ore predominating.

The greatest depth attained in the examination of the deposits is about 100 ft. No evidence of secondary enrichment from descending solutions has been noted, and as the ore exposed in the lowest workings is well below water-level, it is probably representative of what will be met with on sinking further.

Palladium-mercury

British Guiana.—Early in 1924 a few minute grains of a greyish-white metallic substance which had been found in a diamond-bearing gravel in the neighbourhood of Oewang, near the Kaieteur gorge, were submitted to chemical analysis in the Government Laboratory in Georgetown. The Director of Science and Agriculture, Sir J. B. Harrison, decided that the mineral contained palladium and rhodium, and a record of the work was published in *The Official Gazette*, May 3, 1924.

As this was the first recorded occurrence of these rare metals in British Guiana it led to considerable interest being taken in the matter by the diamond-seekers in the Kangaruma district, about sixteen miles from the scene of the discovery mentioned above, and a larger quantity of the mineral was secured for analysis in the Government Laboratory. According to a statement in the *Official Gazette*, February 28, 1925, by Sir J. B. Harrison and C. L. C. Bourne, the complete examination showed the mineral to be palladium mercuride. The variations found in the specimens so far examined in British Guiana are as follows :

	1.	2.	3.
Specific gravity	15·0	15·82	13·48
Palladium with traces of rhodium, platinum and gold . . . . *per cent.*	34·8	35·9	45·6
Mercury . . . . . *per cent.*	65·2	64·1	54·4

The mineral is sufficiently hard to scratch rolled nickel ; it has a crystalline structure and retains part of its mercury when heated to temperatures approaching the melting point of pure palladium. The discovery of this mineral in British Guiana is of considerable interest as neither palladium nor mercury has previously been found in the colony.

Petroleum

Paraffin Dirt.—An article on " paraffin dirt " by Henry B. Milner has appeared recently (*Mining Mag.*, March 1925, p. 73).

" Paraffin dirt " is the name applied to a particular type of soil occurring in the Gulf Coast region of Texas and Louisiana, and is believed by some to be a surface indication of petroleum. A report by A. Wolf on the chemical analysis of the substance is included in the article and entirely confirms impressions obtained from microscopical and other investigations made by Milner. Paraffin dirt is petrologically an argillaceous soil, whose detrital constituents are closely related to the recent deposits of the Gulf Coast plain, though it contains an abnormal amount of organic matter. The term " paraffin dirt " is a misnomer ; it is not paraffinaceous and is not a residual product of inspissated petroleum, and therefore cannot be regarded as an indicator of petroleum.

New Zealand.—The petroliferous areas of New Zealand are dealt with by P. G. Morgan (*New Zeal. Journ. Sci. and Techn.*, 1925, 7, 287–290).

Indications of petroleum are unusually strong in three districts, viz. : North Westland (South Island), New Plymouth (Taranaki), and Gisborne (North Island).

At Kotuku, 21 miles E. of Greymouth, North Westland, the surface gravels over an area of several acres are heavily impregnated with oil, and considerable quantities can easily be detected by digging holes. One shallow bore is said to have produced 14,000 gals., and several hundred barrels have been obtained from other shallow bores. A shaft sunk here proves that below the surface gravels are Pleistocene sands, gravels and clays, which overlie Middle Tertiary mudstone and limestone; then come marly and sandy beds underlain by a conglomerate resting on Palæozoic argillites and greywacke. There appears to be a gentle anticline in the Tertiary rocks, slightly complicated by faulting. A good many bores have been drilled into the Tertiary strata, but so far only "shows" of oil have been obtained. The oil of Kotuku is of good quality with a paraffin base. At Fireball Creek, near Kumara, the Middle Tertiary limestone along an anticlinal axis (Brunner anticline) has a smell of petroleum. The structure and other conditions are favourable for the accumulation of oil.

The oil prospects of Taranaki Province, North Island, are referred to in the Imperial Institute Monograph *Petroleum* (1921, p. 40). The total production at New Plymouth has amounted to probably between 40,000 and 50,000 barrels, and there is still a small production. The oil came from depths of 2,000 ft. to 3,000 ft., and was associated with a large amount of gas and with a moderate amount of salt water. The oil, which is of good quality with a paraffin base, comes from Pleiocene strata, underlain by Miocene beds. The Blenheim bore at New Plymouth was put down to 5,276 ft., in Upper Tertiary strata. At 2,200 ft. an appreciable amount of oil was met with, but no flow was encountered at deeper levels. In other wells drilled in the district, only light shows of oil were found. The Taranaki Oil Wells, Ltd., is about to bore at a point 17 miles S.E. of New Plymouth, where a favourable structure has been discovered.

In Gisborne, East Cape District (North Island), indications of oil are plentiful. A considerable amount of boring has been done, and a few barrels of oil, mostly of a light character, have been obtained. The oil seems to come from Upper Cretaceous beds. Recent work by the Geological Survey shows that the Upper Cretaceous shales, sandstones and limestones of the northern part of the district are petroliferous over considerable areas. Although the structures are very irregular, the geologists are hopeful that one or more pools exist.

Russia.—The oil indications of Sakhalin (or Saghalien) are referred to in the Imperial Institute Monograph *Petroleum* (1921, p. 63). Some later information on the results of recent geological investigations is given by Hironao Nishihava (*Eng. and Min. Journ.-Press*, March 14, 1925, p. 449).

The entire eastern coast north of the fiftieth parallel is hemmed with sandy terraced beaches between 3,000 and 4,000 ft. wide and about 60 ft. high. There are swamps and a few inland lakes. The main hill range rises to an average height of 300 ft. behind this chain of swamps and lakes. The oil seeps occur along the eastern coast in Tertiary sandstones and shales, and are especially distinct at Oha, Ehabi, Nutovo, Boatasin and Nogulik. At certain places large areas of the swamp and basin are covered with " Kir " (an impure asphalt). Near Oha, this is said to cover an area of 250,000 sq. ft.

Recent investigations indicate the existence of many strong anticlines. Several anticlinal folds have been located at Oha, where the axis, pitching north, is about two miles long. There are other anticlines at Ehabi, Nutovo, and Kongi River. The dip angles in most cases are about 30°, which is considered the most favourable angle for the accumulation of petroleum. The seeps are evidently located on or near the anticlinal axis along its strike line.

During the Japanese military occupation of North Sakhalin, exploration work has been persistently carried on, and there are now reported to be thirty producing wells with an average total output of 250 barrels a day.

The following are the results of distillation trials of crude oils of sp. gr. 20·5° Bé. and 25° Bé. from the Oha and Nutovo districts respectively.

Oha District.	*Per cent.*	Nutovo District.	*Per cent.*
0–200° F.	5·7	0–250° F.	3·0
200–250	8·3	250–300	25·0
250–300	7·7	300 and over	72·0
300 and over	78·3		

United States.—The oil and gas fields of the Lost Soldier—Ferris District, Wyoming, are described by A. E. Fath and G. F. Moulton (*Bull.* 756, *U.S. Geol. Survey*, 1924). During the spring of 1916 commercial quantities of oil were found by drilling in the Lost Soldier Flats, in South Central Wyoming. This marked the beginning of an oil and gas field development that has resulted in the discovery of the Lost Soldier, Ferris, Mahoney, G. P., Wertz and O'Brien Springs fields.

The rocks of greatest importance belong to the Cretaceous system and include, commencing with the oldest, the Cloverly formation with Muddy sand at the top ; the Mowry shale ; the Frontier formation with the Wall Creek and one or two other sands ; and a producing sand that is thought to belong to the upper part of the Niobrara shale or the lower part of the Steele shale. All these formations yield either oil or gas or both within the district.

In the Lost Soldier-Ferris district nine domes and anticlinal folds have been found, of which the flexures may be as recent as post-Oligocene age. The Lost Soldier dome yields oil from the Wall Creek and associated sands of the Frontier formation, and from the deeper Mowry shale and the Muddy sand of Cloverly age. In the Bunker Hill dome the shallowest known oil-bearing stratum lies at a depth of more than 5,000 ft. The Ferris dome yields oil from the Mowry shale, and large quantities of gas from the Muddy sand. The Wertz dome contains small quantities of oil in the Mowry shale and large quantities of gas in the Muddy sand. The G.P. dome yields oil from a sand that is considered to lie in the lower part of the Steele shale or the upper part of the Niobrara shale.

By the end of 1921, the Lost Soldier field had thirty-two producing wells. From 1916 to 1921, inclusive, the production amounted to 865,887 barrels. The oil (from the Wall Creek sand) has a paraffin base and a specific gravity of about 0·8675 (31·4° Baumé). The three oil wells of the Ferris field from 1919 to 1921 inclusive yielded 29,218 barrels. The oil (from the Mowry) has a specific gravity of about 0·827 (39·3° Baumé), and so is of considerably higher grade than that from the Wall Creek sand. The production of the G. P. field from 1919 to 1921 amounted to 92,562 barrels of oil, similar to that of the Ferris field.

The pre-Cretaceous formations of the region also contain beds that could serve as reservoirs of oil and gas ; and formations as low as the Madison limestone of Mississippian (Carboniferous) age possibly contain oil and gas.

Potash

France.—It was recently reported that potash deposits had been located at Castagnède, near Salies-de-Béarn, France (*Chem. and Met. Eng.*, 1925, **32**, 158).

The potash beds, said to be 90 metres thick, have been struck at a depth of 180 metres. A sample taken at 213 metres was found on analysis to contain nearly 12 per cent. of potassium chloride.

Spain.—Interesting information is given in the *Amer. Fertilizer* (1925, **62**, Jan. 10, p. 35), concerning recent development in the exploitation of the Catalonian deposits of potash. A Company (Minas Potassicas de Suria) has been very active during the past year, the work accomplished including the completion of a 20 ft. shaft to a depth of 1,220 ft.

A factory for the mechanical and chemical treatment of the carnallite is in course of construction together with electrical power plant and storage accommodation.

Galleries driven at various levels have confirmed the previous estimates of the richness of the deposits in potash minerals. It is stated that about six hundred men are now employed on this deposit.

United States.—Information is now available regarding the potash-bearing strata recently located by sinking a well at Cowden Ranch, Crane County, Texas (*Amer. Fertilizer*, 1925, **62**, Feb. 7, p. 72). Analyses were made of cuttings taken at every 5 ft. at depths between 560 and 1,765 ft. The best sample, taken from a depth between 1,065 and 1,070 ft., contained 7·40 per cent. of potash (K_2O). The percentage in eight other samples from various depths ranged from 1·62 to 7·20 per cent. No other sample contained as much as 1·50 per cent. of potash.

Silver

Australia.—Recent developments at Mount Isa, Cloncurry District, Queensland, are described by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, Jan. 1925, p. 13. Compare this BULLETIN, 1924, **22**, 97, 380).

The lode-channel on which the Black Star and other mines are situated has a length of at least 2,000 ft. and a minimum width of 210 ft. The hanging and foot-wall sections contain 60 and 40 ft. of pay-ore respectively, which is reported to have persisted to a depth of 200 ft. The ore consists of mixed carbonates, galena and blende. At 186 ft. in No. 10 shaft, the ore contained 19 per cent. of lead and 6 oz. of silver per ton, while at 206 ft. it averaged 30 per cent. of lead, 19 per cent. of zinc and 10 oz. of silver per ton.

A gradual but constant increase in the silver contents over the whole face is being recorded with depth in all the shafts on this lode. This is due in part to the fact that the contents of silver and shale bands, separating the high-grade ore bands, show up to as much as 300 oz. of silver per ton whilst near the surface the shale bands generally contain only negligible amounts of lead and silver.

Several shafts have proved the ore shoot of the Black Rock lode for a length of 550 ft., and to a maximum depth of 165 ft. (No. 13 shaft). At that depth the ore assays 26 per cent. of lead and 12 oz. of silver per ton. In another shaft at a depth of 124 ft., the lode contains on an average 33·53 per cent. of lead and 10·53 oz. of silver per ton.

At the Rio Grande lode, an ore shoot has been proved for a length of 500 ft. and a depth of 140 ft., where it is reported to carry 25 per cent. of lead and 14 oz. of silver per ton.

The Mount Isa lode shows 200 ft. of good grade ore to a depth of 44 ft.

Taking into account only the more important lodes at present opened up, the " probable " ore of payable grade is estimated by Saint-Smith at a minimum of 3 million tons to the depths already attained (December 6, 1924).

United States.—Edson S. Bastin has written some observations on the rich silver ores of Aspen, Colorado (*Bull.* 750–C., *U.S. Geol. Survey*, 1924, p. 41). The old silver camp of Aspen is in Pitkin Co., S.W. Colorado. The chief ore horizon is the Silver fault at the base of the Weber (?) shale (Pennsylvanian-Carboniferous). Barytes was first deposited ; then followed tetrahedrite, tennantite, pearcite, and argentite, which formed the rich ore shoots of the Smuggler Union and Mollie Gibson mines. Afterwards finely crystalline galena and some blende were deposited, constituting the " milling ore " which now forms the industrial resource of the district. The rich silver ores were primary. Secondary native silver and some secondary pearcite and argentite occur at a depth of about 1,200 ft.

The following particulars of the Ontario mine, Park City, Utah, are taken from an article by G. W. Lambourne (*Min. and Met.*, Feb. 1925, p. 57).

The country rock, Weber quartzite, is intruded by dykes and massive stock-like bodies of diorite, and is traversed by a system of fissures striking N.E.–S.W. and dipping N.W. The Ontario fissure, from 1 to 100 ft. in width, has been proved for more than 5,000 ft. along its strike. There is a well-defined ore-shoot, 500 ft. long at the surface and 1,500 ft. in length on the 600-ft. level. The ore is argentiferous galena carrying zinc and iron in a siliceous gangue. In the upper levels the ore has been oxidised to a carbonate. The vein carries rich streaks enclosed in low-grade material. In the Wasatch limestone, which is below the Weber quartzite, the ore carries a large percentage of zinc.

A great fault divides the Ontario mine into two nearly equal parts. The eastern area was supposed to be barren, but explorations made recently have opened up large bodies of low-grade as well as some high-grade silver ore, and it is not improbable that in this neglected area lie as great resources as the older portions of the camp to the west, which have already been productive of lead, zinc and silver to the value of nearly $220,000,000.

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Sodium and Magnesium Salts of Western Canada. By L. H. Cole. *Investig. of Min. Res. and the Min. Ind.*, 1923, *Public. No.* 616, *Mines Branch, Dept. Mines, Canada,* pp. 47–53. (Ottawa: King's Printer, 1924).

NOTICES OF RECENT LITERATURE

THE HANDBOOK OF SIERRA LEONE. By T. W. Goddard, M.B.E., B.A. (Oxon.), Assistant Colonial Secretary. Pp. xvi + 335, 8¾ × 5¾. (London: Grant Richards, Ltd., 1925.) Price 10*s.* 6*d.*

This volume, which is issued with the authority of the Sierra Leone Government, can be regarded as a reliable official account of the history and present condition of the Colony and its attached Protectorate. Sierra Leone is unique among British Colonies in that it was started as a residence for liberated African slaves, and an interesting account is given in the present work of the steps taken to settle these expatriated people and the manner in which the Colony gradually assumed its present status and prosperity.

The more utilitarian part of the book deals with the administration, finance, trade, agriculture and communications of the Colony and Protectorate, and provides a valuable compendium of information for all interested in the commerce of the region, as well as for intending residents, who would be well advised to peruse the volume before proceeding to the country.

The book is issued in the form of a volume of travel rather than a mere handbook, and its attractiveness is increased by a number of interesting photographs and two good maps. The author and his colleagues in the administration are to be congratulated on a very excellent piece of work.

OFFICIAL YEAR BOOK OF THE COLONY OF SOUTHERN RHODESIA. No. 1—1924. Containing General Information and Statistics. Pp. xvi + 329, 9¾ × 6. (Salisbury, Southern Rhodesia: Art Printing and Publishing Works, 1924.) Price *7s. 6d.*

The authorities of the new Colony of Southern Rhodesia have lost no time in arranging for the issue of a practical and well-produced Year Book. Officials, private residents and business men alike will find in the present volume a mass of general and special information on the various aspects of the country's life and administration, as well as accounts of its history, natural features, ethnography and antiquities. All who are in any way concerned with the new Colony should read this work, in which "the present position of the Colony is shown and some of its great potentialities indicated."

It may be suggested that future issues should include a detailed topographical map, and also one showing the Colony in relation to the adjacent territories, in addition to the useful maps which appear in the present edition. A few errata are noted in an inserted slip, but it would seem that to these should be added one on p. 31, where the reference to the "Roman Conquest of Britain" should (by the context) presumably read the "Norman Conquest of England."

THE OXFORD ECONOMIC ATLAS. By J. G. Bartholomew, with an introduction by L. W. Lyde, M.A. Sixth Edition, Revised by John Bartholomew, M.A., F.R.G.S. Pp. xii + 64, 11¼ × 9. (Oxford: The University Press, 1925.) Price *6s.*

This useful publication contains in a relatively small compass over 100 maps, as well as numerous diagrams, dealing on broad lines with every part of the world and with all the chief aspects of economic geography—such as principal products, population, vegetation, meteorology, commerce and communications. In the Introduction, Professor Lyde offers some concise and instructive explanatory notes on the principal features dealt with in the atlas. The colouring of the maps is so devised as to set out the features of each in the best way, and the work as a whole is excellently printed. A set of maps not usually found in atlases of this kind is one showing in outline the countries of the chief colonial Powers and their over-seas possessions, on a uniform scale; and it may be suggested that in future editions geometrical diagrams might be added to show the corresponding relative populations.

The atlas is mainly intended for use in schools, but it can be recommended to a much wider public, and particularly to commercial men with overseas interests.

AGRICULTURAL CO-OPERATION IN THE BRITISH EMPIRE. Edited by K. Walter, with an Introduction by Sir Horace Plunkett, K.C.V.O., F.R.S., etc. Pp. 254, 9¼ × 6. (London: George Routledge & Sons, Ltd., 1925.) Price 10*s.* 6*d.*

On the occasion of the British Empire Exhibition last year the opportunity was taken to hold a conference on Agricultural Co-operation in the British Empire. The conveners of the Conference were the Trustees of the Horace Plunkett Foundation, and this book is a record of the proceedings which took place at Wembley during the four days of the Conference, July 28–31, 1924. In the appendixes are reprinted the original memorandum calling this, the first Conference of Agricultural Co-operators throughout the Empire, and a copy of the schedule of the information desired. The particulars asked for in the schedule fall under four heads, as follows: (*a*) Propaganda and Organisation; (*b*) The Work of Co-operative Societies; (*c*) Federation; and (*d*) General. A considerable amount of useful information was thus obtained and has been incorporated in the book.

The following subjects were discussed at the various sessions of the Conference: State Policy; Co-operative Credit; Co-operative Marketing; Producers and Consumers; Federation; Future Work of the Conference; Juvenile Organisation; and Better Living. Reports of these discussions are given in the second part of the volume. The Conference was attended by delegates from England, Wales, Ireland, Scotland, Newfoundland, Canada, Australia, New Zealand, South Africa, India and Malaya, and this fact adds materially to the value of the discussions.

An introduction to the book is contributed by Sir Horace Plunkett, who is so well known for his work in connection with the agricultural co-operative movement in Ireland, and in this he summarises the results of the Conference and emphasises the formula of the Irish agricultural co-operators—better farming, better business and better living—which the Conference fully endorsed.

Agricultural co-operation in this country has made but little progress for various reasons, not the least being a lack of knowledge of the subject on the part of those chiefly concerned. This book should contribute materially to the spread of the movement which has for its aim the political, economic and social advancement of agriculture, particularly in the English-speaking world.

PARRY'S CYCLOPÆDIA OF PERFUMERY. By Ernest J. Parry, B.Sc., F.I.C., F.C.S. Vol. I, A—L, pp. 1–432; Vol. II, M—Z, pp. 433–840, 9½ × 6¼. (London: J. & A. Churchill, 1925.) Price 36*s*.

This work, compiled by a well-known English authority on essential oils, is "a handbook on the raw materials used by the perfumer, their origin, properties, characters and analysis; and on other subjects of theoretical and scientific interest to the user of perfume materials, and to those who have to examine and value such materials." For recipes for finished perfumes the reader is referred to books of a more empirical character, though really good recipes are seldom published.

The sources and methods of production of important perfumery materials are in most cases dealt with very comprehensively in the present work, and their chemistry and analysis fairly fully described. These two volumes constitute, moreover, a valuable fund of information on a vast number of lesser known and recently discovered aromatic materials likely to be of interest to the practical perfumer. Essential oils of purely scientific value will not be found in this cyclopædia, and constituents such as terpenes, which are of no great use in perfumery, are dismissed in a few lines and their chemistry is not discussed. Special articles concerned with the general examination of, and detection of adulterants in, materials employed by the perfumer are well written and contain much useful information.

A few monographs have been contributed by other specialists in this branch of chemical industry: "Determination of Alcohols in Essential Oils" and "Sesquiterpenes," by C. T. Bennett, B.Sc., F.I.C.; "Alcohols," "Benzylidene-acetone" and "Piperitone," by M. Dewhurst, B.Sc., F.I.C.; "Distillation of Essential Oils" and "Colour and Chemical Constitution," by T. H. Durrans, M.Sc., F.I.C.; "Higher Fatty Aldehydes," "Anthranilic Acid Esters" and "Phenylethyl Alcohol," by A. W. Garden, B.Sc., F.I.C.; "Artificial Esters in Essential Oils" and "Citronella Oils," by M. Salamon, B.Sc., F.C.S.; "Soap Perfumery," "Vanillin" and "Vanishing Creams," by W. H. Simmons, B.Sc., F.I.C.

The work is thoroughly up-to-date, and no recent research or patent of any importance dealing with essential oils or synthetic perfume materials appears to have been omitted.

This cyclopædia will undoubtedly prove an extremely useful book of reference to all connected with the perfume industry.

THE SEASONING AND PRESERVATION OF TIMBER. By Ernest G. Blake, M.R.S.I., A.B.I.C.C. Pp. xii + 132, 8½ × 5½. (London: Chapman & Hall, Ltd., 1924.) Price 9*s*. 6*d*.

While this little book cannot be claimed as affording a technical guide to the seasoning and preservation of timber, it provides a useful account of the methods employed in commercial practice, and should prove helpful to those requiring information in non-technical language regarding the prevention of monetary loss resulting from the decay of timber employed for construction or other industrial purposes. The growth and structure of timber, and the causes of its decay, are briefly considered in the first two chapters; on the whole the information given on these subjects will be useful to the layman, but this section of the book is capable of improvement. In seven short chapters the various methods of preserving, drying and seasoning timbers are well described, and there is repeated evidence that the author has made every effort to bring his information up to date. He points out that local circumstances and particular requirements must be taken into consideration in deciding which of the several methods of preservation available can most usefully be adopted in a specified instance, and that it may not always be possible to employ the creosoting impregnation process which is now generally considered to afford the most satisfactory results. Special attention has been given to the description of methods employed in modern creosoting, and the chapter concerned, which includes an illustrated reference to the "incising" method of creosoting, is abreast of the times. A well-illustrated chapter describes the various types of modern impregnating plant. There is also a useful chapter devoted to a description of wood "preservatives," most of which are intended by the manufacturers to act in a dual capacity as preventives of decay and as ornamental stains.

The chapter on dry-rot is an interesting and useful account of this timber disease, and affords practical information regarding the early symptoms of attack and advice as to the measures which should be adopted in coping with attacks and in preventing a recurrence of them. The book is well printed and indexed.

Scientific Preservation of Food. By Thomas M. Rector. Pp. xi + 213, 7¾ × 5¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925.) Price 10s.

The author of this work is a consulting chemist who has been engaged for many years in the application of the principles of chemistry and bacteriology to problems involved in the preservation of foods.

The subject is treated in an elementary manner so as to be intelligible to non-technical readers, and no attempt has been made to describe in detail the actual methods and manipulation employed in the preparation and packing of foodstuffs.

After a brief review of the different classes of foods and the various causes of spoilage, the methods of preservation are dealt with in connection with their suitability for application to particular foodstuffs, and the different kinds of containers are mentioned.

The book is interestingly written, but is not altogether free from blemishes; for example, on pp. 12 and 13 we find the oyster, clam and snail referred to as crustaceans, and on p. 35 trichina is mentioned as an "insect parasite."

The Rare Earths, their Occurrence, Chemistry and Technology, 2nd Edition. By S. I. Levy, M.A., Ph.D., F.I.C. Pp. xvi + 362, 5½ × 8½. (London: Edward Arnold & Co., 1924.) Price 18s. net.

The general plan of this edition is identical with that of its predecessor. Several changes have been made, however, in the subject matter, the most noteworthy being the omission of titanium (as it is not a member of the rare earth group), and the inclusion of recent information relating to isotopes, radioactivity and the bearing of X-ray analysis on the structure of rare earth minerals.

The sections dealing with the chemical and physical properties of the rare earths have been revised with great care, but it is to be regretted that the information bearing on their occurrence and utilisation has not been brought up to date with the same thoroughness. For example, no reference can be found to the very important deposits of uranium ore in the Katanga region (Belgian Congo) which for several years past have produced radium in such quantities as to control the price of the metal.

The treatment of the subject of Chapter VI ("The Monazite Sands") lacks balance, for whereas a fair description is given of the United States occurrences, which have not produced much more than 200 tons of monazite since

1911, those in Travancore, which produced 16,000 tons during the same period, are dismissed in a few lines and the deposits are not assigned to any particular district.

It may be pointed out that the statement on p. 81 to the effect that the crude Travancore sands contain 46 per cent. of monazite is incorrect as applied to the sand recovered during recent years, the average being probably less than one-fourth of that amount.

The author states (p. 87) that monazite occurs sparingly in the gem gravels of Ceylon, but omits to make reference to the important beach deposits at Bentota, where an electromagnetic separator has been installed for some years and has recovered several hundred tons of high-grade monazite, rich in thoria.

The book will continue to be of service to those interested in the rare earths, and will serve as a useful introduction to the technology of their industrial utilisation.

A TEXTBOOK OF GLASS TECHNOLOGY. By F. W. Hodkin, B.Sc., A.I.C., and A. Cousen, M.Sc., A.R.C.Sc., A.I.C. Pp. xxiii + 551, 9¾ × 6. (London: Constable & Co., Ltd., 1925.) Price 42*s*.

This volume, emanating from the Department of Glass Technology of the University of Sheffield, represents the first systematic attempt of recent years to provide a reliable source of information in English on the principles of glass-making. As the book is intended for the practical glass-worker, as well as for the scientific student of glass technology, the authors have confined themselves to giving a general introduction to the subject and have omitted discussion of the more complex theories.

The book opens with a short historical account of the glass industry, followed by a chapter on the basis of glass technology, in which the underlying chemical principles are lucidly explained. The various physical and optical properties of glass and their dependence on chemical constitution are next discussed in the light of the most recent researches on the subject. The questions of the viscosity of the various types of glass and the necessity for annealing glass-ware are dealt with, and the value of durability is emphasised.

The next section of the book deals with the raw materials for glass-making, consideration of the essential acidic and basic oxides of which the body of the glass consists being followed by that of the miscellaneous materials employed, such as those used for decolourising glass. Methods of calculating the various mixtures and of preparing, storing and mixing raw materials are given. The composition of the finished glass and the process of devitrification are also discussed.

The different types of fuel, methods of determining the value of fuels by calorimetry and of measuring furnace temperatures, and the adaptation of different fuels to special purposes are considered.

The various kinds of refractory materials met with are described in relation to their different uses, and an excellent account is given of the manufacture of glass house pots.

The authors give a full description of the various furnaces of all types needed in glass manufacture, including direct and semi-direct fired, gas and oil furnaces of both the regenerative and recuperative types, and the special "lehrs" or annealing furnaces.

The concluding section of the book deals with the manipulation of glass for different purposes. The steps involved in the manufacture of all kinds of glass-ware from common bottles to optical glass and cut and decorated hollow-ware are described.

The book is well illustrated, and is provided with full author and subject indexes, and a bibliography.

YEAR BOOK AND DIRECTORY of the South African Engineering and Mining Journal. Pp. xcvi + 242, 9½ × 13½. (Johannesburg, 1925.) Price 10*s.* 6*d.*

The 1925 edition of this useful and well-known publication, which has just appeared, is on the lines of its predecessor, being divided into two sections, the Directory and the Year Book.

The former gives details of over 200 mining and industrial companies in the Union of South Africa and Rhodesia, a list of mines in Southern Rhodesia, information on the South African electrical supply companies, and also contains much matter relating to mining and engineering supplies.

The Year Book comprises considerable information on the gold, diamond, coal, tin, copper, asbestos and other mineral industries of the Union, Rhodesia and the Belgian Congo, including special descriptions of the more important undertakings. In the Engineering and Industrial section details are given of many of the other industries carried on in South Africa.

THE CONSTRUCTION OF WELLS AND BORE-HOLES FOR WATER SUPPLY AND THE ELEMENTS OF THE ANALYSIS

AND PURIFICATION OF WATER. By J. E. Dumbleton, Assoc.M.Inst.C.E., A.E.R.Ae.S. Pp. xiv + 134, 8½ × 5½. (London: Crosby Lockwood & Son, 1925.) Price 10*s.* 6*d.*

This work deals with the theory of springs, the yield and construction of wells and the various methods of boring used for obtaining water. The remaining chapters are on bore-hole pumps—including a description of the Boulton water elevator—notes on wells and borings, the properties of potable water and water to be used for industrial purposes, and on water analysis and purification.

This work is a considerable advance on Swindell and Burnell's *Rudimentary Treatise on Wells and Well-Sinking*, published fifty years ago, and which is alluded to in the Preface, but it must be admitted that the portion of the work relating to boring appliances has already been largely covered by C. Isler's *Well-Boring for Water, Brine and Oil*, published in 1921.

Figures 19 and 21 are wrongly labelled. Fig. 19 represents a worm auger and fig. 21 a flat V-chisel. Under the heading "Rotary Boring" only diamond drilling is described. The latter is a special form of rotary boring, but it is not the ordinary one for which steel drilling bits are used.

PORT ADMINISTRATION AND OPERATION. A Review of Systems of Management in Vogue in Various Countries. By Brysson Cunningham, D.Sc., B.E., F.R.S.E., M.Inst.C.E. Pp. vi + 179, 8½ × 5½. (London: Chapman & Hall, Ltd., 1925.) Price 13*s.* 6*d.*

In this book the author gives "a broad view of the methods by which port affairs are administered under different conditions and by different systems." As he himself admits, however, the work does not pretend to be a completely comprehensive account of port administration throughout the world. The field of investigation covered has been mainly confined to the leading ports of Great Britain and her Dependencies, of the chief maritime nations in Europe, and of the United States. Eighteen excellent photographic illustrations are provided. There are also nine diagrams mainly intended to elucidate the organisation at various ports.

The book should prove of considerable value to the studious enquirer who is engaged in the work of port administration. The author is to be congratulated on the success with which he has condensed so vast an amount of information into a single volume.

BOOKS RECEIVED FOR NOTICE

THE BRITISH COMMONWEALTH AND ITS UNSOLVED PROBLEMS. By C. M. MacInnes, B.A. Pp. x + 176, 7¼ × 4¾. (London: Longmans, Green & Co., 1925.) Price 5*s.*

NORTH AMERICA. By J. Russell Smith. Pp. viii + 849, 8¾ × 5¾. (New York: Harcourt, Brace & Co., 1925.) Price, Library Edition, $6·00; Text Edition, $4·75.

PECAN-GROWING. By H. P. Stuckey and Edwin Jackson Kyle. Pp. xiii + 233, 7½ × 5. (New York and London: The Macmillan Company, 1925.) Price 12*s.* 6*d.*

ONZE KOLONIALE LANDBOUW. TWAALF POPULAIRE HANDBOEKJES OVER NEDERL.-INDISCHE LANDBOUW-PRODUCTEN, ONDER REDACTIE VAN DR. J. DEKKER. III. DE KINACULTUUR. Door Dr. A. Groothoff. Pp. 122, 9 × 6. (Haarlem: H. D. Tjeenk Willink & Zoon, 1925.) Price F.2·25.

DIE GERBSTOFFE UND GERBMITTEL. By H. Gnamm. *Chemie in Einzeldarstellungen, XII. Band.* Pp. 394, 9½ × 6¼. (Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1925.) Price 24 gold marks.

DIRECTORY OF PAPER MAKERS OF THE UNITED KINGDOM FOR 1925. Pp. 280, 10¼ × 7¼. (London: Marchant Singer & Co., 1925.) Price 5*s.*

ANATOMY AND PHYSIOLOGY OF THE HONEYBEE. By R. E. Snodgrass. Pp. xv + 327, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1925.) Price 17*s.* 6*d.*

LOW TEMPERATURE DISTILLATION. By Sydney H. North and J. B. Garbe. Pp. vii + 216, 8¼ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1925.) Price 15*s.*

THE DESIGN OF RAILWAY LOCATION. By Clement C. Williams. Pp. vii + 517, 9 × 6. Second Edition, Revised. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1924.) Price 20*s.*

With reference to the notice of *Cotton in South Africa*, by W. H. Scherffius, published in this BULLETIN (1925, **23**, 124), copies of the book may be obtained in this country from Messrs. Gordon & Gotch, Ltd., 15 St. Bride St., E.C.4.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

ECONOMIC PRODUCTS FROM DOMINICA

THE chief industry in Dominica is the growing of limes, the products of which, viz. lime juice, green fruit and citrate of lime, form the bulk of the exports from the island. Cocoa and coconuts are also grown for export, but the sugar industry, at one time of much importance, no longer exists. A number of other commodities are produced on a small scale or experimentally, and samples of these, as well as of the staple products, may be seen in the Dominica section of the British Empire Exhibition at Wembley. Certain specimens which have been exhibited there have been forwarded to the Imperial Institute by the Hon. Commissioner, West Indian and Atlantic Group Committee, in order to ascertain their quality and market value in this country. These are dealt with in the following pages.

1. CAMPHOR

A sample of camphor received consisted of small, transparent, granular crystals of very pale cream colour and fairly good aroma. It was found to have the following constants, which are shown in comparison with those of a commercial sample of pharmaceutical camphor and also with the British Pharmacopœia requirements :

	Dominica Camphor.	Commercial Pharmaceutical Camphor.	British Pharmacopœia Requirements.
Specific gravity at 15·5°/15·5°C.	0·9954	—	About 0·995
Melting point	175° C.	179° C.	About 175° C.
Optical rotation [1]	+ 10·4°	+ 10·8°	About + 10°
Solubility at (15·5° C.)[2] in			
Chloroform	0·34	0·34	0·25
Alcohol, 90 per cent. (by weight)	1·25	1·2	1
Olive oil	4·0	4·0	4
Water	750	750	About 700

[1] *Determined at 15·5° C. in a 10 cm. tube of a solution in 90 per cent. alcohol containing 25 grams of camphor per 100 c.c. of solution.*

[2] *Number of c.c. of solvent per gram of camphor.*

The solution of the Dominica camphor in water was opalescent and had an oily appearance at the surface, whilst that of the commercial sample used for comparison was quite clear. Its solutions in organic solvents were yellowish and slightly turbid owing to the presence of a small amount of extraneous matter.

When triturated with chloral hydrate, menthol, phenol and thymol, both the Dominica sample and the commercial sample formed liquids, as specified in the British Pharmacopœia.

As already mentioned, the present sample was slightly discoloured and contained a small amount of oily impurities which rendered its solution in water slightly turbid ; moreover its aroma was not so good as that of the commercial sample of pharmaceutical camphor with which it was compared, but otherwise its properties agreed very well with those of the latter.

Such camphor would find a market for industrial purposes, but would have to be refined by sublimation, either locally or in the United Kingdom, in order to enable it to conform with the standard of purity required by the British Pharmacopœia. The price of British-refined camphor in the United Kingdom is 3*s.* 8*d.* to 3*s.* 9*d.* per lb., and that of the industrial product from 2*s.* 6*d.* to 2*s.* 8*d.* per lb. (December 1924).

2. GINGER

This sample consisted of hands of peeled, washed and bleached ginger, up to 3½ in. in length. The hands were plump, striated, had a short fracture, and were externally of pale pinkish-buff colour ; internally they were pale yellowish-cream. The aroma and pungency were good.

The ginger was examined with the following results, which are shown in comparison with the usual range of figures for commercial ginger, and with those specified in the British Pharmacopœia for ginger used for medicinal purposes.

	Dominica Ginger. *Per cent.*	Commercial Ginger. *Per cent.*	British Pharmacopœia Requirements. *Per cent.*
Matter soluble in cold 90 per cent. alcohol	5·1	3–6	Not less than 5·0
Matter soluble in water	10·1	About 10	Not less than 8·5
Total ash	4·8	3–6	Not more than 6·0
Ash insoluble in water	1·4	—	Not more than 1·5

It will be seen from the above table that the analytical figures for the present sample fall within the usual limits for commercial ginger, and also agree with those specified by the British Pharmacopœia. The ginger used for medicinal purposes must, however, be unbleached, but the demand for this is comparatively small.

The sample was described by commercial experts as " medium " ginger, worth 135*s.* to 140*s.* per cwt., spot, in London, with first-grade Jamaica ginger at 160*s.* per cwt. (January 1925). The firm mentioned that the prices then current were high on account of the decrease in the supply at the end of the season, and that ginger of the same quality as the present sample was being sold for future delivery at 115*s.* to 120*s.* per cwt.

This Dominica ginger was well prepared and of good, attractive appearance, and supplies of similar quality would be readily saleable in the United Kingdom. It had been bleached rather more than is necessary ; first-grade Jamaica ginger is slightly darker than the present sample.

3. VANILLA

This sample consisted of typical vanilla pods, 8 in. long and ⅜ in. wide, of dark chocolate-brown colour and good appearance. The pods had not the fine aroma of Bourbon vanilla, and a slightly sour odour was noticeable.

On chemical examination the pods were found to contain 1·9 per cent. of vanillin. Bourbon pods, which are the best commercial variety, usually contain from 1·9 to 2·9 per cent. of vanillin.

Importers in London to whom the pods were submitted regarded them as inferior to the Bourbon variety, and considered that they would not realise much over 40*s.* per lb. in the United Kingdom, with Bourbon pods of the same length at 48*s.* per lb.

4. Gommier Resin

Three samples of gommier resin were received, one in the crude state and two prepared samples described as "incense gum." They were as follows :

(1) "*Gommier Resin. Crude.*"—Opaque, irregular lumps of fairly hard, rather brittle oleo-resin, varying in size from small pieces to lumps about 3½ in. long and 2 in. broad. The resin, which varied in colour from cream to pale yellowish-brown, had a slight camphoraceous and turpentine-like odour. The sample was free from extraneous matter.

(2) "*Incense Gum* (*Lumps*)."—Fairly regular lumps, up to 2 in. by 1¼ in. by 1 in. in dimensions, apparently consisting of a prepared resin. The material was dark reddish-brown (transparent in thin layers), and had a slight camphoraceous odour. The sample contained a small amount of insoluble extraneous matter.

(3) "*Incense Gum* (*Flakes*)."—Flakes of resin about ¼ in. thick, varying in length up to 1½ in. and in breadth up to 1 in. The resin was similar in character to sample No. 2, but rather darker, and a slightly larger amount of extraneous matter was present.

Examination of the samples gave the following results, which are shown in comparison with the corresponding figures for three samples of Gommier resin from Dominica examined at the Imperial Institute in 1904.

—	Present Samples.			Previous Samples.		
	Gommier Resin.	"Incense Gum" (Lumps).	"Incense Gum" (Flakes).	(1) Hard.	(2) Soft.	(3) Soft.
Loss on heating at 100° C. *per cent.*	6·78	0·61	0·43	—	—	—
Melting point:						
Resin softens at .	88° C.	85° C.	90° C.	158°–164° C.	Below 100° C.	Below 100° C.
Resin becomes liquid at . .	115–120° C.	About 95° C.	100–105° C.			
Acid value . .	34·0	33·9	33·8	14·1	37·3	33·6
Saponification value	70·8	56·9	56·9	24·7	41·6	35·1
Ash . *per cent.*	0·06	0·09	0·09	0·08	0·36	0·19

The three present samples were completely soluble in alcohol, chloroform and ether ; the " incense gum " was also completely soluble in benzene, but the gommier resin was not entirely dissolved by this solvent. All three samples were nearly completely soluble in turpentine oil, but almost insoluble in light petroleum.

The gommier resin furnished, on steam distillation, 1·4 per cent. of a yellowish-brown volatile oil.

On cooling hot alcoholic solutions of the resins, much of the material separated in a crystalline form. After purification by re-crystallisation, the resins thus separated from samples 1 and 2 were found to have the following melting points :

Gommier resin	181° C.
Incense gum (lumps)	178° C.

A solution of 1 part of the gommier resin in 1 part of turpentine oil, when applied to sized wood, furnished a rather uneven, not very lustrous coat, which remained somewhat soft and " tacky " even after two weeks' exposure.

The samples were submitted to firms of brokers in London, who, however, were not able to report favourably on the prospects of marketing such resin in the United Kingdom, although one firm, whilst not recommending the preparation and shipment of the resins, offered to take charge of any consignments which might be forwarded.

Varnish manufacturers, who were also consulted regarding the products, stated that the crude gommier resin appeared to be of the same technical value as the ordinary gum elemi now on the market, whilst the prepared " incense gum " would be inferior from a varnish-making point of view.

Gommier resin is the product of *Dacryodes hexandra*, but it is similar in certain respects to the " Manila elemi " of commerce, which is derived from species of *Canarium*. This latter resin is principally used (*a*) for certain varnishes, in order to render them less brittle and more elastic, and (*b*) in the preparation of printing inks.

Very little gommier resin appears to have reached the

London market hitherto, and it was suggested to the Dominica authorities that if it is desired to ascertain definitely the possibility of shipping the material to the United Kingdom under present conditions, a trial consignment of about ½ ton of the resin represented by sample No. 1 should be forwarded to the Imperial Institute for disposal through the firm of brokers who offered to take charge of shipments.

5. COPRA

Two samples of copra were received for examination; they were as follows :-

No. 1. " Copra from the Alcock Estates."—This was of very attractive appearance, and in sound condition, the inner surface being very white and clean.

No. 2. " Copra from Melville Hall."—This was also in sound, clean condition, and of good appearance, though not so attractive as sample No. 1, the inner surface being cream to light yellowish-brown.

The samples were chemically examined with the following results :

		No. 1.	No. 2.
Moisture	*per cent.*	5·3	5·3
Oil, in copra as received	,,	65·9	66·8
Oil, calculated on the moisture-free copra	,,	69·6	70·6
Acid value of oil		0·3	0·9
Free fatty acids (expressed as lauric acid)	*per cent.*	0·1	0·3

The oils, as extracted by light petroleum, were of normal character.

These results show that both samples contained the usual amount of oil and that the acidity of the extracted oils was satisfactorily low. The percentages of moisture are, however, rather high, the maximum desirable being under 3 per cent.

Copra of the quality of these samples would be readily saleable in the United Kingdom at current market prices. The daily spot prices as fixed by the Committee of the London Copra Association have recently varied from £28 5*s.* to £31 10*s.* per ton, according to the grade and country of origin; West Indian " f.m.s." being quoted at £30 5*s.* per ton in London on July 1st, 1925.

These two samples of copra were of good quality, containing normal amounts of oil of low acidity.

It was pointed out that in the case of consignments of copra shipped to the United Kingdom the moisture should be reduced, by further drying, in order to bring it below 3 per cent. The advantages of the lower percentage of moisture are (1) that there is less likelihood of fungi developing on the copra during storage and transit and so causing an increase in the acidity of the oil, and (2) that such copra is preferred by British buyers, as being more easily worked than a product containing more moisture.

THE SUITABILITY OF CERTAIN NYASALAND CLAYS FOR THE MANUFACTURE OF BRICKS, TILES, DRAIN-PIPES AND POTTERY

In connection with the general question of the manufacture in the Colonies of bricks, tiles, etc., from locally-occurring materials, samples of four clays, collected by the Government Geologist, Nyasaland, have been received recently at the Imperial Institute, and the results of their investigation are described in the following pages.

The possibility of making drain-pipes in Nyasaland is now being considered by the Director of Public Works, and, at his request, information has been supplied by the Institute regarding machines suitable for operation by native hand-labour.

Clay No. 1

This material, described as "marl," was stated to occur on the Tangasi River, south-west of Chiromo, as part of the shale series of the local coal measures.

The sample consisted of lumps of a dark reddish-brown, highly ferruginous, indurated clay, free from coarse sand. On immersion in water the lumps broke up into small fragments, but did not disintegrate into powder.

It appeared probable that on prolonged soaking in water and "weathering" the clay would yield a mixture which could be readily "pugged" into a homogeneous mass of suitable consistence for brick- or tile-making. In order, however, to obtain such a material expeditiously at the Imperial Institute, the clay was prepared, before mixing with water, by grinding it to pass a sieve of 20 meshes to the linear inch. On mixing the ground clay with water a plastic, but not sticky, material was obtained.

A number of bricks and tiles, together with the test-pieces necessary for the determination of physical properties, were made from the "stiff-plastic" material thus obtained, in a hand-power screw-press specially designed for this class of work. Careful air-drying was necessary, and after this operation the specimens, which were then sufficiently strong to bear satisfactorily the incidental handling, were fired to a temperature of 1,040° C., being maintained at that temperature for six hours.

The results of various tests carried out on the unfired and fired material are shown in the following table :

Water used to form mass of suitable consistence	*per cent*	14·8
Maximum firing temperature		1,040° C.
Duration at maximum temperature	*hours*	6
Total time of firing	,,	24
Shrinkage on air-drying	*per cent.*	1·8
Shrinkage on firing	,,	3·8
Total shrinkage	,,	5·6
Transverse breaking stress of unfired clay	*lb. per sq. in.*	205
Transverse breaking stress of fired clay	,, ,, ,,	1,890
Warpage on firing (i.e. deflection of a 6-in. bar from straight)		nil
Porosity (i.e. the volume of the pores expressed as a percentage of the entire volume)	*per cent.*	18·4
Water absorption	,,	8·5
Crushing strength[1]	*lb. per sq. in.*	2,546
Specific gravity of fired material (apparent)		2·08
Weight per cubic foot	*lb.*	129
Colour		Terra-cotta
"Ring"		Good

[1] *The crushing strength of English machine-pressed bricks varies from about* 1,950 *lb. to* 2,650 *lb. per sq. in.*

In comparison with these figures it may be stated that an English commercial roofing-tile of good quality (Yorkshire plain tile) tested at the Imperial Institute showed a transverse breaking stress of about 2,000 lb. per sq. in., and a porosity of 30·7 per cent. A commercial red facing-brick tested at the Institute had a water absorption of 19·2 per cent. ; that of the commercial roofing-tile being 16·8 per cent.

The weight per cubic foot of the commercial roofing-tile was about 105 lb. Commercial machine-pressed bricks of English manufacture vary from about 110 to 150 lb. per cubic ft.

The foregoing results show that the bricks and tiles produced were strong and sound, and compared favourably with commercial English-made bricks and tiles. The shrinkage and porosity of the fired material were low. The clay is therefore well adapted for the manufacture of building bricks and roofing tiles, the only preliminary treatment required being grinding or prolonged weathering.

The suitability of the material for the manufacture of agricultural drain-pipes and pipes of a similar nature was also investigated. No attempt was made to produce glazed or impermeable pipes similar to those used for sewage and sanitary purposes, as the clay is not adapted for these.

The clay was ground to the same fineness as in the brick-making trials, before mixing with water, and "extruded" pipes were then made by means of a hand-power auger-machine. To avoid cracking of the pipes it was found necessary to allow the clay to stand for at least twenty-four hours after being mixed with the water, so that the water might become evenly distributed and thus eliminate, as far as possible, strains due to varying friction at the orifice of the die.

Careful air-drying of the pipes was found necessary, on account of a tendency to warp. The pipes were then fired under the same conditions as the tiles described above, and on testing gave practically the same results as those shown in the table (p. 282), excluding the breaking stress and crushing strength which were not determined. The water absorption (8·5 per cent.) of the fired pipes was practically the same as that (9 per cent.) adopted by the American Society for Testing Materials as the maximum average absorption for standard drain-pipes, made from shale and used for ordinary land-drainage at moderate depths.

In order to increase the porosity to some extent, a quantity of "grog" was prepared by burning the raw clay at a temperature of 1,040° C. and then grinding it to pass a sieve of 20 meshes to the linear inch. A mixture of 70 per cent. of the ground clay and 30 per c his "grog" was mixed with water and left i ity-four hours, and then thoroughly pugged and made into pipes. After air-drying, the pipes were fired under the same conditions as before.

The water absorption of the fired pipes thus obtained was 13·2 per cent., which is almost the same as that (13 per cent.) adopted by the American Society for Testing Materials as the maximum average absorption for standard drain-pipes made from surface clay.

The pipes were obviously sound and strong, and the clay is evidently suitable for their manufacture.

It will thus be seen that this clay from south-west of Chiromo should be quite suitable, if proper methods are employed, for use in the manufacture of building bricks, roofing tiles and unglazed drain-pipes.

CLAY NO. 2

This was described as "Superficial Clay from Roadside opposite Mission Garden, Vungu Vungu Valley." It was reddish-brown and ferruginous, containing much coarse and fine sand and occasional small stones up to about ¼ in. diameter, the total amount of such material obtained on washing the clay being 52·7 per cent. Chemical analysis showed the sample to contain only about 13 per cent. of combined silica, equivalent to about 28 per cent. of clay.

In view of the very large amount of siliceous matter present in the clay it was not considered that any process of purification by washing would be practicable. The entire sample was therefore ground to pass a sieve of 20 meshes to the linear inch, and all tests were carried out with this ground material.

A number of experimental bricks and roofing tiles were made from the ground clay in a hand-power screw-press, and after air-drying were fired at a temperature of 1,050° C. for six hours, the total time of firing being twenty-four hours. The results of the tests carried out on the fired ware are shown in the following table:

Water added to form mass of suitable consistence	*per cent.*	19·5
Shrinkage on drying	„	2·0
Shrinkage on firing	„	2·3
Total shrinkage	„	4·3
Maximum firing temperature		1,050° C.

Time of firing at maximum temperature	*hours*	6
Total time of firing	,,	24
Transverse breaking stress (unfired ware)	*lb. per sq. in.*	169
Transverse breaking stress (fired ware)	,,	208
Porosity of fired ware	*per cent.*	37·6
Water absorption of fired ware	,,	21·3
Specific gravity of fired ware		1·74
Weight of fired ware	*lb. per cubic ft.*	108·6
Warpage (deflection of a 6-in. tile from straight)		nil

The bricks and tiles produced were soft and weak, the fired ware showing a cross-breaking stress of only 208 lb. per sq. in., as compared with about 2,000 lb. for a Yorkshire plain tile. Such materials would not be suitable for building purposes.

The weakness of the fired products also showed that the clay would be unsuitable for the manufacture of flooring tiles.

Trials were made to determine whether the clay could be used for the production of agricultural drain-pipes; it was not of a type suitable for the manufacture of glazed sewerage pipes. In carrying out the tests the ground clay was tempered with water and allowed to stand for forty-eight hours, after which it was put through a pug-mill to ensure thorough mixing. Attempts were then made to produce " extruded " drain-pipes from the semi-plastic mixture by means of a hand-power auger machine, but it was found that the plasticity and binding power of the material were too low.

The above results show, therefore, that Clay No. 2 is unsuitable for the manufacture of bricks, tiles, or drain-pipes.

Clay No. 3

This was described as " Karoo Clay from Cross Roads, Manchewe Valley." It was a yellowish mottled clay, containing very little coarse quartz, most of the free silica being present in a finely-divided form. Some lumps of clay cemented with iron oxide, and iron oxide concretions, were present. The combined silica found on chemical analysis was equivalent to about 53 per cent. of clay.

It was stated by the Government Geologist that hand-made tiles had been experimentally produced from a mixture of equal parts of this clay and sand, and the suggestion was made that better results might be obtained if the tiles were machine-pressed. Experiments carried out at the Imperial Institute showed, however, that a mixture of equal parts of the clay and sand was unsuitable for tile-making, owing to lack of binding power. The best results were obtained with a mixture of 70 parts [illegible] the clay, ground to pass a sieve of 20 meshes to the linear inch, and 30 parts of sand.

For the production of good drain-pipes it [illegible] found necessary to use a fine sand for admixture with [illegible] clay. The sand employed for making experimental pipes at the Imperial Institute was of such fineness that it all passed through a sieve of 50 meshes to the linear inch, whilst that used for bricks and tiles (see below) passed through a 20-mesh sieve.

Bricks, roofing and flooring tiles, and drain-pipes were made from mixtures of 70 parts of the clay with 30 parts of sand, of the appropriate fineness in each case and after drying were fired at a temperature of 1,050° C. for six hours, the total time of firing being twenty-four hours. It seemed possible that instead of using sand it might be feasible to utilise Clay No. 2 in admixture with Clay No. 3, and bricks and tiles were therefore also made from a mixture of equal parts of the two clays and fired under the above-mentioned conditions. It was found, however, that this mixture did not lend itself to the production of good agricultural drain-pipes, owing to a lack of plasticity and binding power.

The results obtained in these trials are shown in the following table:

	70 parts Clay No. 3 and 30 parts Sand.	Equal parts Clay No. 2 and Clay No. 3.
Water added to form mass of suitable consistence . . . . *per cent.*	34·0	23·3
Shrinkage on drying . . . ,,	4·2	6·0
Shrinkage on firing . . . ,,	2·3	5·5
Total shrinkage . . . ,,	6·3	11·5
Maximum firing temperature . . .	1,050° C.	1,050° C.
Time of firing at maximum temperature *hours*	6	6
Total time of firing . . . . . ,,	24	24
Transverse breaking stress (unfired ware) *lb. per sq. in.*	244	292
Transverse breaking stress (fired ware) ,,	720[1]	780[1]
Porosity of fired ware . . *per cent.*	35·3	31·2
Water absorption of fired ware . ,,	20·1	16·4
Specific gravity of fired ware . . .	1·88	1·85
Weight of fired ware . . *lb. per cubic ft.*	117·5	116·4
Warpage (deflection of a 6-in. tile from straight)	nil	nil

[1] *Compared with about 2,000 lb. for a Yorkshire plain tile.*

These results indicate that tiles made from (*a*) 70 parts of Clay No. 3 with 30 parts of sand and (*b*) equal parts of Clays Nos. 2 and 3, are much weaker than the ordinary commercial tiles used in the United Kingdom, but they would probably be suitable for local use.

The bricks made in the trial were sound, and suitable for ordinary building purposes.

It will be noted that the fired ware made from the mixed clays Nos. 2 and 3 was somewhat stronger than that made from the clay-sand mixture, but that the shrinkage was much higher.

With regard to flooring tiles, it is probable that either of the two mixtures would be suitable for the manufacture of such tiles for local use. The tiles made at the Imperial Institute were softer than ordinary flooring tiles, but if properly laid in a cement-sand base and not exposed to heavy wear they would probably prove sufficiently durable for ordinary purposes.

Satisfactory drain-pipes can be made from a mixture of 70 parts of Clay No. 3 with 30 parts of sand. It should, however, be noted that in making such pipes it is essential that the moist clay-sand mixture should be allowed to stand for at least forty-eight hours, in order to ensure wetting of all the particles. This period of rest should be followed by a thorough pugging, the mixture being then transferred to the pipe machine. Drying should not be hurried, as there is a slight tendency to warp.

An improvement in the strength of the resulting products might perhaps be effected by the addition of a small quantity of finely-ground felspar to the foregoing mixtures, or by using Clay No. 4 in admixture with Nos. 2 or 3, but the amounts of clay available at the Institute were insufficient for such tests. For the same reason it was not possible to make sufficient ware for certain physical determinations, such as the crushing strengths of the fired bricks and drain-pipes.

The Government Geologist desired to be informed as to the most economical and easily applied glazes for this ware. It was found at the Imperial Institute that a pleasing, warm brown glaze was obtained by the use of a siliceous galena, containing about 20 per cent. of silica.

The bricks or tiles after firing were moistened, covered with a thin layer of finely-ground galena by dusting from a sieve, and then re-fired to a temperature of about 950° C.

It is necessary, when firing bricks or tiles covered with this glaze, to permit free access of air in order to oxidise the galena, and also to make provision for the dispersal of sulphurous fumes.

If it is desired to use leadless glazes it would probably be more convenient and economical at first to purchase supplies of prepared glazes of the desired colour from manufacturers. These glazes could be applied to the damp bricks or tiles before firing, and the glazing and firing could then be done in one operation.

The galena glaze could be similarly applied to the unfired ware, but this appears inadvisable, as at the temperature at which it is necessary to fire the bricks and tiles the glaze would probably become too fluid, and would tend to give an uneven surface.

A tile made in Nyasaland from this clay, mixed with an equal part of sand, was also received. The tile was roughly made, and contained a considerable amount of siliceous and other coarse material. It was soft, and appeared to be under-fired. The transverse breaking stress was 392 lb. per sq. in., i.e. about half that of the tiles prepared at the Imperial Institute from the same clay (see p. 286). Improvement could be effected by reducing the amount of coarse impurity and increasing the firing temperature.

CLAY NO. 4

This was described as "Karoo Clay from White Clay Pit, Mission Brickfield." It was a greyish clay streaked with stains of iron oxide. It was desired to learn whether this clay could be used for the manufacture of rough pots, plates, cups, etc., for native use, and to ascertain the most suitable glaze that could be applied.

The sample contained a considerable quantity of very fine sand, but not many coarse particles. The amount of coarse material present would not be sufficient to interfere with the utilisation of the clay for the preparation of rough ware for native use, but would be objectionable in the manufacture of fine ware. As the clay was to be tested only for the manufacture of rough ware, no earthenware mixtures with flint, felspar and china clay were made at the Imperial Institute, and the only variation from the use of the raw clay alone was the admixture, in one series of trials, of a quantity of fine sand.

The clay was ground to pass a sieve of 50 meshes to the linear inch, and the sand used for admixture was also passed through a similar sieve.

The clay formed a plastic mass when mixed with water, and worked well on the potters' wheel and on the jigger and jolley machine. A mixture of 80 parts of clay with 20 parts of fine sand was also found suitable for these methods of treatment. Vessels made on the wheel from the clay alone and from the clay-sand mixture were fired at a temperature of 1,050° C. for six hours, the total time of firing being twenty-four hours.

It was found that the articles thus made, such as cups, plates, etc., which would be exposed to rough handling, were rather weak and insufficiently fired. They were therefore re-fired to a temperature of 1,120° C. and maintained at that temperature for two hours, and then showed considerable additional strength. Thick heavy articles, such as jars intended for storage purposes only, would probably be sufficiently strong without re-firing.

There was little difference between the appearance or strength of the vessels made from the clay and the clay-sand mixture, and it is probable that in view of the siliceous nature of the clay nothing would be gained by the addition of sand except a reduction of the high plasticity. The following table shows that there was only a small difference in shrinkage between the clay and clay-sand mixture :

	Clay No 4.	80 parts Clay No 4 and 20 parts Sand.
	Per cent.	*Per cent.*
Water added to form mass of suitable consistence	23·7	22·9
Shrinkage on drying	6·3	6·0
Shrinkage on firing	2·5	2·0
Total shrinkage	8·8	8·0

Clay No. 4, either alone or in admixture with fine sand, should thus be suitable for the manufacture of rough ware for native use without any treatment other than admixture with water.

Coarse heavy ware, to be used for the storage of dry goods, could be glazed either (*a*) by dusting the unfired ware, when damp, with siliceous galena, and firing to about 1,000–1,050° C., or (*b*) preferably by moistening the ware (fired at not less than 1,050° C.) with some very slightly adhesive compound, such as highly diluted gum or molasses, and then dusting with galena and re-firing to about 950° C. The same precautions regarding access of air and removal of fumes would be necessary as in the treatment of tiles (see p. 288).

There is little risk of lead poisoning to the workers when dusting galena on to the ware as this compound has not the poisonous action of white lead, which is often used in the preparation of lead glazes.

In the case of ware intended for cooking purposes, the use of lead glazes gives rise to some risk of food contamination, particularly if the glaze is not properly applied. In order to obtain satisfactory results the glaze must not be fired at too low a temperature, and sufficient time must be given to permit of the formation of insoluble lead silicates, instead of the more soluble oxides. It might, however, be preferable in Nyasaland to employ a leadless glaze for cooking utensils.

The following specimens of ware made at the Imperial Institute were forwarded to Nyasaland with the Reports on the materials. Specimens may also be seen at the Institute by those interested.

1. Brick made from ground marl (Clay No. 1).
2. Tile made from ground marl (Clay No. 1).
3. Drain-pipe made from ground marl (Clay No. 1).
4. Drain-pipe made from ground marl (Clay No. 1) and "grog."
5. Roofing tile, made from equal parts of Clays Nos. 2 and 3; fired at 1,050° C.
6. Roofing tile, made from 70 parts of Clay No. 3 and 30 parts of sand; fired at 1,050° C.
7. Roofing tile, made from equal parts of Clays Nos. 2 and 3, fired at 1,050° C. (glazed at 950° C. with galena).

8. Brick, made from 70 parts of Clay No. 3 and 30 parts of sand ; fired at 1,050° C.

9. Flooring tile, made from equal parts of Clays Nos. 2 and 3 ; fired at 1,050° C.

10. Flooring tile, made from 70 parts of Clay No. 3 and 30 parts of fine sand ; fired at 1,050° C.

11. Drain-pipe, made from 70 parts of Clay No. 3 and 30. parts of sand ; fired at 1,050° C.

12. Bowl, made from Clay No. 4 ; fired at 1,120° C.

13. Vessel, made from Clay No. 4 ; fired and glazed with galena at 1,000° C.

14. Vessel, made from 80 parts of Clay No. 4 and 20 parts of fine sand ; fired at 1,120° C. ; glazed with a soft commercial leadless glaze and glaze stain at 860° C.

ARTICLES

THE CULTIVATION, PREPARATION AND UTILISATION OF THE GROUND-NUT

In response to the large number of applications received at the Imperial Institute for information regarding the ground-nut, an article under the above heading was prepared and published in this Bulletin (1910, **8**, 153–172). Since the appearance of this article the interest in ground-nuts has continued, and it has therefore been deemed advisable to re-publish the substance of the article referred to, with such amendments as the lapse of time has rendered necessary, and with such additional information as is now available regarding the cultivation of ground-nuts in countries of the British Empire.

Extent of Cultivation

The cultivation of the ground-nut extends over a very wide geographical area. The crop is successfully grown in most of the tropical and sub-tropical regions of the world, and also, to a certain extent, in countries where a temperate climate prevails. The ground-nut is used either locally as food, or as an article of export on account of the value of the seeds as a source of oil and of the residual cake as a feeding-stuff.

The countries where ground-nut cultivation plays an important part in agricultural operations are India, Indo-China, Japan, Java ; the South Atlantic States of North America, especially Virginia, Tennessee, the Carolinas and Georgia ; Mexico ; Brazil and the Argentine Republic ; the West Coast of Africa ; East Africa ; Madagascar ; Algeria and Egypt. In Europe it is successfully grown in Spain and in Sicily. Recently the cultivation of the ground-nut has been considerably extended in British overseas countries, especially in Australia, South Africa, Rhodesia, Sudan and Burma.

The total world's production of ground-nuts must be enormous, but it is impossible to compute it with any degree of accuracy as very large, unrecorded quantities are consumed locally in the countries of production. Some idea of the importance of the crop may, however, be gathered from the fact that the world's exportable surplus is at least 800,000 tons. The principal European importing countries and the quantities (in round figures) imported by them during the year 1924 are as follows : France, 530,000 tons ; United Kingdom, 100,000 tons ; Germany, 75,000 tons ; Holland, 65,000 tons ; and Italy, 26,000 tons. The principal countries which furnish large supplies to Europe are India ; the West Coast of Africa, particularly the Gambia and Senegal ; East Africa ; and China. The large crops raised in the United States of America and in Spain are for the most part consumed in the countries of production mainly in the form of food products of various kinds.

THE GROUND-NUT PLANT

The ground-nut of commerce is known under several common names, such as pea-nut, goober-pea, earth-nut, monkey-nut, pindar, Manila nut, Chinese nut, pistache de terre, l'arachide, and in the vernaculars of India and other countries where it is grown, by translations of one or other of the names mentioned.

The plant which produces the ground-nut is known botanically as *Arachis hypogæa*, Linn. It is unknown in a wild state and its native country is a matter of some uncertainty. There is reason to believe, however, that it originated in tropical South America, as several species belonging to the genus Arachis are met with growing spontaneously in that country. Centuries of cultivation have probably so improved the plant that it is no longer comparable with the wild type, if this is still in existence.

The ground-nut plant is an annual herb belonging to the Papilionatæ division of the large family Leguminosæ, whose members are characterised by pea-shaped flowers. In general habit and appearance the plant resembles clover. The leaves, however, differ from those of clover in having four instead of three leaflets. These are arranged on the leaf-stalk in two pairs, and they exhibit at night the sleep-movement characteristic of the leaves of many leguminous plants. The stems attain a length of from 1 to 2, or 3 ft., according to the variety and the soil in which the plant is cultivated. There are several forms of it in cultivation (see p. 305), but in general two types may be recognised, the erect and the trailing. The varietal differences are chiefly in the shape of the mature pod, the number and colour of the seeds they contain and the manner in which the pods are produced on the stem of the plant. The flowers are bright yellow in colour and are of two kinds. Those that are borne above the leaves and are the most conspicuous are sterile and produce no pods. The fertile flowers are borne in the axils of the lower leaves in the erect-growing kinds, and all along the stem in the trailing varieties; they are smaller but more numerous than the sterile flowers and are almost entirely hidden by the foliage. When first produced, these flowers are sessile, that is to say they have no peduncle or flower-stalk; but the tubular calyx, which encloses the ovary, is often ¾ in. in length, and is sometimes mistaken for the flower-stalk. After fertilisation takes place the true peduncle develops, and continues to grow until it reaches a length of several inches. It takes a downward turn, and when it reaches the soil it pushes the ovary several inches beneath it. In this position the ovary develops its seeds and in a few weeks the pod matures, forming the familiar ground-nut of commerce. If the stalk is prevented from penetrating the soil, no seeds are produced and no pod is formed. This peculiarity is of importance to the cultivator, as it indicates how essential for this crop is a fine surface tilth on the soil, which enables the delicate flower-stalk bearing the ovary to penetrate it easily. When mature, the pod may contain from one to as many as four seeds, according to the variety, but two is the usual number. The seeds are generally ovoid in shape with one end pointed and the other flattened, and are covered with a reddish-purple or yellow seed-coat.

In common with other leguminous plants, the roots of the ground-nut plant bear nodular growths. These are due to the action of bacteria which inhabit them, and which have the power of fixing the free nitrogen of the atmosphere and rendering it available for the plant which serves as host. In consequence of this the ground-nut plant does not depend entirely upon the soil for the nitrogenous food it requires, and it is thus possible to cultivate ground-nuts on soils which are not particularly rich in nitrogenous constituents.

CULTIVATION

The ground-nut is not a difficult crop to cultivate provided the few essential conditions are forthcoming. The details of cultivation naturally differ in countries so widely separated as the regions mentioned above, but the following account gives the general procedure in most countries.

Climatic Conditions

In tropical countries the life cycle of the ground-nut plant is accomplished in from three to four months according to the variety. In more temperate regions some five to six months may elapse between the time of sowing the seed and the maturing of the fruit. It is apparent from a study of the geographical area over which the ground-nut is cultivated that it is possible to grow the crop under climatic conditions which differ considerably. In tropical regions there is always sufficient heat for this crop, and the only uncertain element is the rainfall; but the crop can be grown under irrigation, where the rainfall is scanty. In temperate countries the summer heat usually suffices to mature the pods although a longer time is required, but the late frosts in the spring and the early frosts of autumn are frequently a source of danger. A temperature of 58° or 59° F. appears necessary for the young plants when commencing growth, and any diminution of warmth, even if it be only 2° or 3°, affects them detrimentally. As a guide, it may be stated that where maize or citrus fruits can be grown and ripened the ground-nut may be successfully cultivated, and in temperate regions a period of at least five months free from frost is necessary in order to mature the crop, the most favourable conditions being an early spring, followed by a warm, even, summer temperature with a well-distributed rainfall, and a dry autumn. The sowing takes place as soon as all danger from frosts is over and the condition of the soil is such as to admit of working it.

In tropical countries with well-defined wet and dry seasons the ground-nut crop is cultivated during the rains, and the whole of the vegetative growth is completed during the wet season. The sowing takes place as soon as the rains have sufficiently moistened the soil, and by the time the dry weather sets in the crop is mature and ready for harvesting.

On the West Coast of Africa the rains are accompanied by a rise in temperature, and these climatic conditions suit the ground-nut admirably ; its growth is rapid and the crop matures quickly. In Madras the seed is sown from about the middle of June to the middle of August on rain-watered land, and on irrigated land from February–March to the middle of May. In Bombay it is usually a " kharif," or rain crop, and is sown in June as soon as the rains have sufficiently moistened the land, but in the Deccan it is grown as a " rabi," or winter crop, on irrigated land.

Soil

The first condition required of a soil destined for the cultivation of ground-nuts is that it should have a fine surface tilth. The necessity for this arises from the peculiarity of the plant, already mentioned, in burying its fertilised ovaries beneath the soil in order to mature the seeds. A fairly rich sandy loam appears to be the most suitable soil for the crop, and it is an advantage if it is light in colour as the pods are liable to be stained if grown in a dark-coloured soil. When required for sowing or for oil-pressing, the appearance of the pods is not of great importance, but when the seeds are to be used for edible purposes, light-coloured, clean pods fetch an enhanced price on the market. Abundance of lime is essential for the crop, and where lime is lacking it should be added in the form of quicklime. The absence of lime from the soil is supposed to account for the production of "pops" or empty pods. A fair amount of humus or decayed vegetable matter is beneficial, but if too plentiful the haulm is liable to develop at the expense of pods. Badly drained, sour, salt or clayey soils are unsuited to the crop, but good yields have been obtained from stony soils rich in sand where a plentiful supply of sub-soil moisture is available.

Preparation of the Soil

If new country is being brought into cultivation it will be necessary to cut down trees, shrubs or undergrowth, should they exist, and these should be burnt on the land as the ashes form a valuable manure for ground-nuts. In countries where primitive methods of culture are practised the land is simply hoed by hand to a depth of from 2 to 4 in. In sandy soils the surface is left level, but in more compact soils it is thrown into ridges to afford better drainage. Where mechanical appliances are available the land is ploughed a short time before sowing if a previous crop has been taken off it ; but if it is to be newly broken, the preliminary ploughing is carried out in autumn and is followed in spring by rolling and harrowing to break up the clods and render the surface smooth and friable. The depth of ploughing depends entirely on the character of the soil, but from 5 to 7 in. of loose soil is sufficient depth for the ground-nut. If the land is deeply cultivated the nuts are liable to be formed low down in the soil and this involves more labour for harvesting them. Where there is no manure to be turned in and the land is level and in a clean condition, the disk plough, as used in the United States, is a useful machine for producing the fine surface tilth required by the crop.

It is advisable to cultivate the ground-nut as a rotation crop, as not only does this practice prevent the exhaustion of the soil, but the alternating crops are benefited by the good culture which the ground-nut demands and by the increased amount of nitrogenous matter contained in the soil as the result of having borne a leguminous crop. As, however, the whole plant, including the roots, is harvested, the soil does not benefit to the same extent as it does when a leguminous crop is ploughed in as manure. Local practice and demand will to a certain extent determine what plants to use as rotation crops with ground-nuts ; amongst others that have proved suitable are maize, millet, sesamum, cotton, tobacco and manioc (cassava). The alternation of other crops with the ground-nut has the further advantage of checking the attacks of insect pests which are liable to occur when the crop is grown on the same land for several years in succession. In certain districts in Madras it is intersown in a cereal crop. In all cases when grown in rotation, ground-nuts should follow a well-cultivated crop that has been kept free from weeds. In Queensland the ground-nut is recommended as an under-crop for orchards, either to be ploughed in or harvested.

Manures

Advantage should be taken of the rotation system of cropping to apply farmyard manure to the land, but if this is done the same year that a crop of ground-nuts is grown, the haulms are liable to make rank growth at the expense of the nuts. It is therefore advisable to manure the crop which immediately precedes the ground-nuts. In Madras, cattle or sheep are sometimes herded on the black cotton lands intended for ground-nuts for a few weeks before ploughing.

In addition to farmyard manure, artificial fertilisers may be used with advantage if the soil is poor, but care should be taken not to overdress the land or luxuriant top growth will be the only result. These fertilisers should contain from 1 to 4 per cent. of available nitrogen; 5 to 7 per cent. of phosphoric acid and from 6 to 10 per cent. of potash.

Wood-ashes which contain both lime and potash may be applied broadcast to the land at the rate of from 25 to 30 bushels per acre. Soils that are deficient in lime should receive dressings of fresh burned lime every four or five years at the rate of from 1,000 to 2,000 lb. per acre. In India, tank or channel silt is much valued as a ground-nut manure. It varies in composition according to locality and in some instances is saltish and worthless. The open sandy material is of the most value; this is applied at the rate of about 10 cart-loads per acre annually. The silt used in the South Arcot District of Madras has been found on examination to consist of about 22 per cent. of lime and about 70 per cent. of fine sand. It is applied to the land once in about four years at the rate of from 50 to 100 cart-loads per acre.

Sowing

Care should be taken to use only good seed for planting. With native cultivators it frequently happens that only the unsaleable nuts of poor quality are available, and to this is probably due the degenerate crops and poor yields which obtain in some localities. In order to produce good results and to improve the crop, seeds should be saved from the best yielding plants and these should be grown in nurseries and carefully harvested for sowing in the field the following year. The nuts intended for seed should be fully matured on the plants and should be carefully picked by hand and stored in a dry place free from attacks by vermin.

In Madras, seed for sowing is preferred from irrigated land; the nuts produced on high and dry soils of a compact nature being considered unsuitable for this purpose.

Either the whole "nuts" or the decorticated seeds may be used for planting. If the former are used the germination of the seed is delayed until the shell has decayed and permitted the young plant to escape. This takes but a few days in tropical countries where decay is rapid, but in dryer and cooler regions the use of whole nuts for planting causes an appreciable delay in germination. The germination of whole nuts may, however, be accelerated by soaking them in cold water for about twenty-four hours and allowing them to drain for a few hours before planting. Another method of accelerating the germination of undecorticated seeds is simply to break the pods in two, leaving the seeds *in situ*. Where decorticated seeds are used the pods should be opened by hand and care taken not to injure the delicate seed-coat, as injury or bruises are liable to be followed by decay after the seed is planted. One of the advantages of shelled seed is the opportunity afforded during the shelling for eliminating any that are defective, hence the better " stands " that usually result when decorticated seeds are sown. The seed to be used for planting should not be shelled until a short time before it is required for use, as it is liable to lose its power of germination.

Machines have been devised for planting ground-nuts, and are in common use in the United States. They are similar in structure to those used for planting cotton seed, and effect a great saving in labour. In South Africa the maize planter is adapted for sowing decorticated ground-nuts.

The seed is usually sown in straight rows or drills, and where hand-planting is practised the land should be first marked out. This is easily done by means of an improvised harrow with teeth set at the required distance. The seeds may be dropped in the lines made by the harrow at regular intervals and covered with soil by the foot. The depth at which the seeds should be planted varies from 1 to 1½ or 2 in., according to the character of soil. The heavier the soil, the shallower should be the planting. The distance between the rows depends upon the variety grown, and local conditions ; and also as to whether hand or machine cultivation is to be employed. If the latter, the rows must of course be spaced sufficiently wide apart to admit of the working of the machine cultivator. A common distance for planting in the United States is 36 in. between the rows and 12 in. from plant to plant, while in the Madras Presidency the seeds are sown about 5 in. apart, each way. In Rhodesia the heaviest yields have been obtained with the Spanish variety planted 18 in. by 6 in.; but less than 24 in. between the rows involves hand cultivation. If planted too thickly the branches of the trailing varieties overspread each other, and many of the stalks fail to reach the ground, and in consequence do not form pods; on the other hand the erect varieties, if planted too thinly, do not cover the ground and the crop is liable to suffer from drought in consequence. Experience of the local conditions and of the habit of the variety grown, is the only safe guide on this point, but not less than 1 ft. or more than 3 ft. between the rows should be given. Should serious gaps appear in the rows a supplementary sowing will be necessary, and this should be carried out as soon as possible after the plants from the first sowing appear above the ground; or seedlings may be transplanted to fill the gaps.

After-Treatment

As soon as the young plants have attained a height of from 1 to 2 in., the soil between them should be hoed. Where machines are available the horse-hoe or cultivator can be used for this purpose and much hand-labour saved thereby. Frequent hoeing is necessary, as this operation not only checks the growth of weeds and prevents the evaporation of moisture from the soil, but also produces the necessary fine surface tilth. The number of hoeings necessary will depend upon the character of the soil and the rate at which the weeds grow, but as soon as the haulms have developed sufficiently to cover the soil this work may cease. In making the later hoeings the soil should be drawn towards the plants, and this should be carefully done or the first-formed pods may be injured.

Harvesting the Crop

In tropical countries the stems begin to fade as soon as the rains have ceased and the dry weather has set in. This is an indication that the plants are ready for harvesting. It is advisable to lift the plants as soon as the stems show sign of fading, as then the pods are firmly attached to the stem and are not so liable to be detached during the process of lifting. Care must, however, be taken to see that the maximum number of nuts are mature, as they ripen successively. In the case of compact soils, which retain moisture for a considerable time, a longer period for ripening is required. The ripening season is a critical period, as if rain falls before the crop is lifted, after a spell of dry weather, the seeds in the first-formed pods are liable to start into growth, and are then of little or no value as oil-seeds. For this reason also, when the crop is grown under irrigation, the supply of water must be so managed that it is just sufficient to mature the crop, and it must not be continued after the first-formed nuts are mature.

There are various methods of harvesting the crop. Native cultivators either use a large hoe with which to lift the plants, or dig them up with a fork. Any nuts that become detached are gleaned by women and children, or hogs are turned into the field to consume those that are left in the soil. On irrigated land in India, harvesting is sometimes effected by flooding the land. This is carried out by first removing the stems and allowing the land to become quite dry in order to thoroughly ripen the pods. The land is then moistened and ploughed several times to expose the pods, and flooded with water. The ripe pods float and are drifted by the wind, or swept by a broom made of twigs into one corner of the field, where they are collected, dried and winnowed.

The Chinese cultivator harvests his crop very thoroughly. He lifts each plant with a spade-like implement and throws it, together with the soil which adheres to the roots, into a bamboo sieve, which is shaken by another operator. The soil passes through the meshes of the sieve and the pods are retained. Any chance pods that escape are gleaned, or poultry and pigs are turned into the fields to feed on them.

In temperate countries the plants should be lifted as soon as they are found to be well set with pods and before autumn frosts occur. In the United States several mechanical appliances are in use for lifting ground-nuts. The simplest is the ordinary turning plough from which the mould-board is removed. This is run along the rows, and the roots of the plants are severed just below the nuts; the stems are then lifted by hand, shaken free from soil and left on the ground to dry. From 5 to 7 acres per day may be lifted in this manner by a driver with a pair of horses followed by a gang of from eight to ten men. The ordinary machine potato-digger is also suitable for lifting ground-nuts. This machine not only severs the roots, but lifts the plants from the soil and leaves them on the surface of the land. One man with two or three horses and a machine of this type can lift from 8 to 12 acres per day. After being lifted the stems are collected into small heaps and left to dry for several days or weeks, according to local climatic conditions. If lifted in dry weather and carefully cured they make an excellent fodder (see analysis, p. 330). When required for this purpose the stems should be protected from rain by covering the tops of the heaps with straw or grass.

Ground-Nut Hay

In the United States great care is taken to secure a good fodder from the stems as well as to mature the nuts thoroughly. The following is the method of drying and curing usually practised :—The stems are left for a few hours after lifting, and are then collected and formed into a number of small heaps, each arranged round a central stake or pole, which is about 7 ft. long and firmly fixed in the ground. To the base of the pole, and a few inches from the ground, two pieces of wood are nailed crosswise on each other and at right angles to the pole. The object of the cross-pieces is to prevent the stems from coming in contact with the soil. Successive layers of stems are built up round the pole until the top is reached. The pods are kept towards the centre of the heap and the leaves to the outside. A slope is given to the stems in order to throw off rain, and the tops of the heaps are covered with straw, grass or weeds for the same purpose. The shocks are sometimes arranged in single rows in the field, or collected into groups, or stacked close together in an enclosure.

This method of stacking in small heaps permits an abundance of air to circulate around the stems, and prevents mildew, which is liable to attack the somewhat fleshy haulms if stacked in large heaps or in barns.

Picking the "Nuts"

The separation of the pods from the stems is usually effected by hand, where the necessary labour is available. This is a tedious and expensive method, but, as it is not laborious, women and children engage in the operation. The pods should not be picked until they have become quite dry and the seeds firm and nutty, and empty or shrunken pods should be allowed to remain on the stems. During wet or foggy weather the stacks should not be opened, as exposure to wet discolours the pods, and the haulms would be spoiled for use as fodder. Thrashing the stems with a stick (Plate V, fig. 1) is a more expeditious method of removing the pods, but by this practice many of the pods get damaged and the stems are rendered less valuable as fodder, as many of the leaves are broken off. The broken leaves are separated from the pods by winnowing (Plate VI, fig 2). Provided the stems are well set with pods, a good picker can handle from 8 to 12 bushels per day. Machines are now available for thrashing ground-nuts, and these are capable of turning out 200 to 500 bushels a day.

After being plucked or thrashed the pods should be spread out to dry and then put into sacks or stored in granaries protected from rain. In the tropics, where a long period of dry weather can be depended upon, they are stored in large heaps before being shipped ; and in the French colonies on the West Coast of Africa improvised granaries of wicker-work are built for the purpose of storing them. In the United States the pods are treated in a cleaning factory, where they are brushed, winnowed and graded.

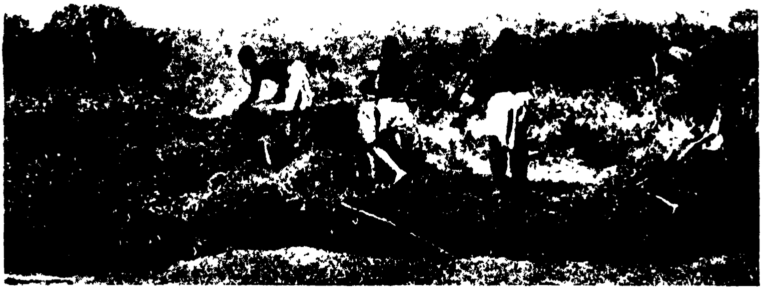
Decorticated Nuts

In some cases the nuts are decorticated for export in order to save freight space or to lessen the transport charges. Decorticated nuts or " kernels " do not keep so well as nuts in shell, and for this reason the shells should not be removed until as short a time as possible before shipping. Machines are now available for decorticating nuts and these are preferred as the nuts are decorticated dry; but many of those exported from Coromandel (India) and Kano (Nigeria) are hand-shelled by beating with sticks and winnowing. It is a common practice in India to wet the nuts intended for hand-shelling in order to soften them. This practice often causes fermentation, which renders the oil derived from the kernels unfit for edible purposes. Where sufficient hand-labour is not available the modern shelling machines should be employed wherever possible (see p. 325). With a view to eliminating the need for decorticating the nuts in order to reduce freight charges, a process for pressing and baling ground-nuts in their shells has recently been devised, by which it is claimed that the natural bulk of the nuts can be reduced to less than one half. This process, known as the MacIlwaine Patent Process, is protected by British Patents Nos. 186,133, 186,277 and 187,257. Although the shells of the ground-nuts are in most cases broken by this process the kernels remain uninjured. As the latter still retain the protection of the shell and, owing to compression and the protection of a hessian covering, are not exposed to the air as are decorticated nuts, they are said to stand transport without deterioration. This process therefore appears to be suitable for use in those countries where transport facilities are inadequate or where the labour for decorticating the nuts is expensive or not available.

Yield

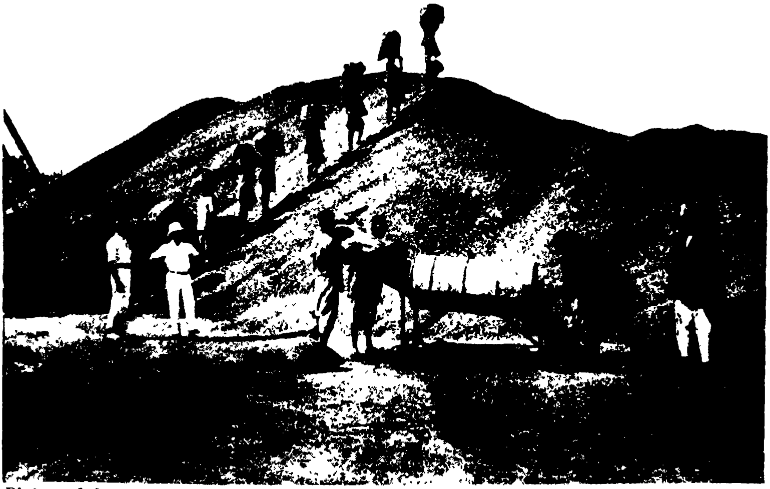
The yield varies with local conditions and the variety grown, and more especially with the amount of cultivation the plants receive. With proper methods of cultivation a good average yield is about 60 bushels per acre, though yields of 100 to 160 bushels per acre have been recorded. Owing to the continuous cropping of the same land with ground-nuts, areas in the State of Virginia which formerly yielded an average crop of from 50 to 75 bushels (= 1,200 to 1,800 lb.) per acre, now yield considerably less, the average for the last 3 years being 780 lb. per acre. In North Carolina, the average for this period was 930 lb.,

PLATE V



Photograph by M. T. Dawe.

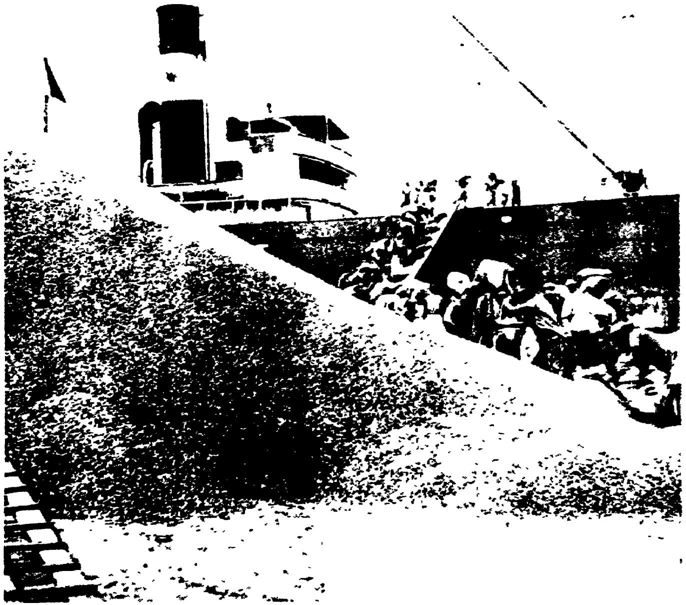
FIG. 1.—Natives thrashing ground-nuts in the Gambia.



Photograph by A. J. Brooks.

FIG. 2.—Screening ground-nuts in the Gambia by means of a rotary screen.

PLATE V



Photograph by A. J. Brooks.

Photograph by M. T. Dave.

whilst in the other chief producing States the average is less than in Virginia. The average yields per acre in the chief producing Provinces of India in recent years have been as follows: Madras, 1,030 lb.; Bombay, 1,800 lb.; Burma, 775 lb. In the Gambia the yield is from 50 to 60 bushels per acre, and in Senegal it is reported to be from 1,500 to 1,800 kilos. per hectare on good land, the average being about 1,000 kilos. The yield obtained in Java by ordinary native methods of cultivation is low, averaging only 430–510 kilos. per hectare, but with intensive cultivation on favourable soils the yield reaches 1,700 kilos. or more. In Japan the average production per acre during the ten-year period 1911–20 was 87·8 bushels.

The yield of fodder per acre averages about 1 ton, but may be as much as 1½ to 2 tons according to the soil and the season.

Varieties

In nearly every country where ground-nuts have been cultivated for a long period of time, varieties peculiar to the locality have been produced. From this it would appear that by following a systematic course of seed-selection, it would be possible to obtain varieties suited to particular localities, to special soils or peculiar climatic conditions. Already much has been done to improve the yields in countries where they had deteriorated, by introducing new varieties or seed obtained from other localities. Where fungoid pests are prevalent it seems particularly advisable to follow this course, care being taken to obtain seed from sources known to be free from disease. Hitherto, very little appears to have been done, however, in the production of new varieties by breeding on modern genetic lines.

The numerous varieties of ground-nut may be grouped into two classes: (1) *Arachis africana*, Lour., which is supposed to have originated in Brazil and spread thence to countries bordering the Atlantic Ocean; and (2) *A. asiatica*, Lour., believed to have spread from Peru to countries round the Pacific and Indian Oceans. *A. africana* is of creeping or running habit, with straggling or semi-prostrate branches that bear pods at intervals along their length ; the branches are more or less glabrous ; the pods nearly always contain two seeds ; the husk is friable, being easily broken by the pressure of the fingers, and the seed-coat is pale red in colour. In *A. asiatica*, on the other hand, the stems are more or less erect, with the pods bunched together near the main root, the branches and the underside of the leaves more or less pubescent, the pods usually three-seeded, and the seed-coat dark red. All known varieties approach more or less one or other of these two types, but many combine the characters of both.

In Senegal the varieties in common cultivation approach *A. africana* in characters, being semi-prostrate in habit, the pods small, and usually two-seeded. These are the kinds known in commerce as Rufisque or Cayor. Varieties producing large pods that are two-seeded, and others that are small and contain only one seed, are, however, frequently met with. Consignments of pods from Saloum frequently contain a quantity of both these last-named forms. Less widely grown in Senegal is a small two-seeded variety which has erect stems, and reaches maturity at least a month earlier than the common forms. In the Niger Valley five varieties are distinguished ; one of these is of the " erect " type and the remainder of the " running " class. Besides the two-seeded Senegal type, a large quantity of three-seeded pods are produced in Casamance, as well as very large two-seeded pods which are borne by the so-called " elephant " variety. On the Guinea coast similar varieties are grown, and in addition two local forms are met with, one of which has erect and the other spreading branches. In the British Possessions on the West Coast varieties similar to those which obtain in French territory are cultivated. These varieties are used chiefly for oil-production. The Egyptian variety is prostrate in habit, and produces two-seeded pods of the Senegal type. In South Africa the variety most commonly grown is that known as " Virginia bunch " (see p. 308). A local variety called " Kaffir " is a small-podded form with small seeds, that does not harvest well, owing to the brittle nature of the stalks. On the Mozambique coast a prostrate variety is grown which produces small two-seeded pods, and a more common form that produces pods containing three seeds. Good results have been obtained in India by cultivating this kind. Several other races are grown in India, where they are spoken of collectively as the " ordinary " or " indigenous " varieties. They are of semi-prostrate habit, and usually produce small two-seeded pods. There are said to be two forms in cultivation in Ceylon and two in the Malay Peninsula. The type cultivated in Java belongs to the erect-growing class, with the two-seeded pods produced in clusters or bunches at the base of the stems. The pods of this form are peculiar in that they have but a slight constriction between the seeds, which is such a marked feature in the pods of other varieties, particularly those of the *A. africana* type. Amongst other forms grown in Java is one with longer pods that contain from three to four seeds, and another, very quickly maturing form, bearing one-seeded pods. Samples of Chinese ground-nuts received at the Imperial Institute from Hong Kong show that at least two forms are cultivated in China ; one of these produces a fairly large pod containing two large seeds, and the other a small one- to two-seeded pod with the reticulations strongly marked on the surface.

Some nine or ten distinct varieties of ground-nuts are grown in the United States, as well as a number of hybrids, off-types and mixtures of these (*Farmers' Bulletin* 1127, *U.S. Dept. Agric.*). The varieties known as Virginia Bunch, Virginia Runner and North Carolina, furnish the greater part of the large-podded nuts on the American market. The first-named is stated to have been derived from the Virginia Runner by selection, but the characters of the two are now clearly defined and a number of special strains of each have been developed. The Spanish varieties, including the Small Spanish, medium White Spanish or true Spanish, and the Large or Improved Spanish, furnish the bulk of the shelled nuts and those used for oil-production. The following brief description of the chief varieties met with in the United States is compiled from the above-mentioned *Farmers' Bulletin* and *Farmers' Bulletin* 356.

Virginia Runner.—A strong-growing form of spreading habit and producing pods both at the base of the plant and along the stems. The pods are large and each contains two seeds of a pink or brown colour. This variety is grown extensively in south-eastern Virginia and north-eastern North Carolina.

North Carolina.—This resembles the Virginia Runner, but is smaller in every respect. It possesses characters which indicate that it may be closely related to the African form. Nuts of this variety are used largely for shelling.

Virginia Bunch.—An erect-growing form of rather dwarf habit, bearing large pods at the base of the stem. The pods are similar in appearance to those of Virginia Runner. This variety is easy to cultivate and not difficult to harvest.

African.—A low-growing, runner variety, requiring a long season for its maturity. It produces a heavy yield of nuts, which are fairly high in oil content, but this variety has not found general favour on the American market.

Spanish.—An erect variety of vigorous habit of growth with small, usually two-seeded pods produced at the base of the stems. This is the most important variety in the Southern United States, especially outside the Virginia–North Carolina district. It is the variety best adapted for all purposes in the Gulf coast region and is the one most in demand by factories producing shelled nuts for the market.

Small Spanish.—This form occurs in many sections of the Gulf coast region. It is a variety and strain of the true Spanish, the pods and nuts being about two-thirds the size of those of that form. It is not a high yielder, and the nuts are a little too small to meet the usual market requirements.

Improved Spanish.—A number of hybrids or selections from the true Spanish are known under the names of Improved Spanish, Jumbo Spanish, Large Spanish, and various other local names, their chief characteristic being the large size of the pods and nuts. Some of these are considered to be worthy of careful trial and cultivation, but their use is so far confined to limited areas.

Valencia.—A variety of vigorous upright growth, with the pods clustered at the base of the plants as in the case of the Spanish. The nuts are reddish in colour and not considered desirable for shelling purposes.

Tenessee Red.—This form belongs to the Valencia type, and is possibly a cross or selection of that variety. Its pods are long and slender, with three to seven red seeds in each. It is not extensively used for shelling, but is sold for roasting in the shell.

Georgia Red.—Another variety related to Valencia, sometimes known as Red Spanish. The pods are short and usually contain two or three light red seeds. This form is grown extensively in Georgia, Florida and Alabama, especially for hog feeding.

Pests and Diseases

Although all parts of the ground-nut plant are liable to damage by insects, yet few pests appear to attack well-cultivated crops of ground-nuts when in the field. In West Africa the plants are liable to attack from a number of insect pests, but they are usually able to withstand such attacks if growing vigorously. In dry seasons, however, they may be affected by the drought and then more easily succumb to insect attack. It is important, therefore, during a dry season, to keep the surface soil hoed in order to produce a dry mulch which prevents evaporation of soil moisture, and this, by keeping the plants more vigorous, tends to check the ravages of insect pests.

In Ceylon and South India the most serious insect pest is a small moth (*Anacampsis nerteria*, Meyr.) which deposits its eggs on the leaves of the plant. When the minute greenish larvæ hatch out they burrow into the leaf-tissue, which quickly withers and turns black. When about three weeks old they enter the cocoon stage and bind two or three leaves together with webs from which eventually the moth emerges. The whole life-cycle of this moth is completed in about a month, and as ground-nut plants are always available either on irrigated or rain-watered land, brood succeeds brood throughout the year. Dry weather favours the pest, and owing to its habit of burrowing in the leaf-tissues, spraying is not of much use as a remedy. In order to keep the insect in check, the use of light traps is recommended, as large numbers of the moths are attracted by a bright light at night.

Another insect pest which causes damage in Madras is *Amsacta albistriga*, Wlk., a white-winged moth with abdomen banded yellow and black. This moth deposits large numbers of yellowish-white eggs on various plants and, from these, small hairy caterpillars emerge which ultimately attain a length of 1½ in. When about forty days old they pupate 4 or 5 in. below the surface of the soil. The pupæ, of a reddish-brown colour, remain several months below the soil and develop into moths after the summer rains. It is during the caterpillar stage that injury is done to the ground-nut crop, and the best method of control is by hand-collecting the moths before eggs are laid. The underground pupæ may be exposed by ploughing the fields that were badly infested during the previous season, and may be collected and destroyed or left to be devoured by birds.

Locusts sometimes eat off the foliage, and so reduce considerably the yield of pods. Termites also prove troublesome in some cases by eating the leaves and stems, leaving the nuts isolated in the ground, thereby making harvesting more laborious. In the United States the presence of a root aphis has been detected, but so far it seems to have done little harm to the crop.

Weevils and beetles are liable to attack ground-nuts when stored in granaries, but can do little damage to sound pods. The seeds in broken pods, or decorticated seeds, however, suffer considerably from their ravages. Fumigation by means of sulphurous vapour produced by burning sulphur is recommended to control these pests.

A leaf-spot fungus occasionally attacks the leaves, particularly during a wet spring or on badly drained land. This can be kept in check by spraying with Bordeaux mixture in well-drained soils, but is more difficult to eradicate on wet land. Its presence on the leaves not only reduces the crop of pods, but also spoils the haulms for use as hay.

The " tikka " disease which occurs in India and in most countries where ground-nuts are grown, is also caused by a fungus (*Cercospora personata*) which attacks the leaves, causing brown spots to appear which ultimately spread to large areas. The leaves lose their green colour, turn yellow and ultimately fall. The fungus forms quantities of spores on the under-surface of the leaves of the plant, and in consequence is difficult to treat by spraying as the leaves are close to the ground. As the early-maturing varieties appear to suffer less than the later kinds, it is advisable to grow the former where this pest is prevalent, and to introduce new varieties from non-infested areas.

According to a report by the Division of Botany, Union of South Africa (*Journ. Dept. Agric.*, 1924, **9**, No. 5, 448), a certain amount of damage is caused to ground-nut crops in the Transvaal and Natal by species of Melasma which are parasitic on the roots of the ground-nut plants, causing those that are attacked to turn yellow as if affected by drought and ultimately to die without yielding a crop. The species of Melasma are flowering plants of the family Scrophulariaceæ, and as they produce a quantity of very small seeds they are liable to be carried from place to place in soil adhering to tools and machinery. Farmers are warned to keep a sharp look out for these plants and to eradicate by hoeing any that may be found.

GROUND-NUT PRODUCTION IN COUNTRIES OF THE BRITISH EMPIRE

The following is a brief summary of the present position of ground-nut cultivation in those countries of the Empire where ground-nut cultivation is an established industry or where experimental cultivation has shown that it is possible to produce this crop. Specimens of nuts from these countries may be seen in the Public Exhibition Galleries of the Imperial Institute (see Plate VII).

Asia

India is not only the most important ground-nut producing country in the Empire but is also the principal ground-nut exporting country of the world. The estimated crop areas and yields in India for the year 1924–25, compared with preceding years, are given in the following table which is taken from the *Indian Trade Journal* (1925, **76**, 286).

—	Area (*acres*).			Yield of nuts in shell (*tons*).		
	1924–25.	1923–24.	Average preceding 5 years.	1924–25.	1923–24.	Average preceding 5 years.
Madras . . .	1,839,000	1,812,000	1,392,000	905,000	746,000	650,000
Burma . . .	452,000	390,000	301,000	165,000	115,000	104,000
Bombay (including Indian States) .	348,000	400,000	224,000	326,000	213,000	180,000
Hyderabad . .	134,000	204,000	[1] 168,000	11,000	12,000	12,000
Total .	2,773,000	2,806,000	2,085,000	1,407,000	1,086,000	946,000

[1] *Average for two years.*

The tracts in the three Provinces and State of Hyderabad given in the above table comprise about 94 per cent. of the entire ground-nut area of India, i.e. Madras 65·1 per cent. ; Burma 13 per cent. ; Bombay 10·2 per cent. ; and Hyderabad 5·1 per cent. The cultivation of the ground-nut in Burma is of comparatively recent date and the area under the crop continues to expand.

Towards the end of last century the Indian trade in ground-nuts had fallen very low, owing to disease and low prices, but with the introduction of disease-resisting varieties and an increased demand, together with the better prices brought about by the war, the trade has now recovered and the area under the crop has considerably increased.

India is a large consumer of ground-nuts, and only a portion of the total production is available for export ; by far the larger share of the exports are taken by France. The following table shows the quantities and principal destinations of the exports of ground-nuts for recent years from British India, to which have been added as far as available those exported from ports in the French Possessions in India, the bulk of these having been produced in British India.

In Ceylon and British Malaya the ground-nut is grown on a small scale for local use, but the crop is unimportant, and there is no export from these countries. In Ceylon during recent years successful trials with ground-nuts as a rain-fed dry-land crop have been carried out at the

PLATE VII

Exhibit of ground-nuts and ground-nut products in the Gambia Court, Imperial Institute Galleries.

Exports of Ground-Nuts from India

To	1919–20.	1920–21.	1921–22.	1922 23.	1923–24.	1924–25.
	tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
United Kingdom .	7,920	23,596	7,891	11,078	15,987	35,411
France . .	75,427	39,210	149,200	178,719	191,446	197,687
Germany . .	—	2,002	23,702	24,656	10,852	36,781
Belgium . .	9,755	20,156	23,290	10,409	6,506	16,208
Italy . . .	12,064	11,207	17,407	23,513	8,620	21,607
Other Countries .	6,569	17,844	14,401	19,009	23,634	71,430[1]
Total . .	111,735	114,015	235,891	267,384	257,045	379,124
From Ports in French Possns. .	30,853	15,020	41,953	37,959		
Grand Total .	142,588	129,035	277,844	305,343		

[1] 38,698 *tons to Netherlands.*

Experiment Station at Jaffna. As a result of these trials the Department of Agriculture have distributed seed to local growers with a view to encouraging the cultivation of the crop in the Jaffna district.

In the Federated Malay States experiments are being conducted by the Department of Agriculture with the object of extending ground-nut cultivation, and it has been considered that ground-nuts would form a suitable rotation crop with Roselle (*Hibiscus Sabdariffa*). In the Straits Settlements there is a small distributive trade in ground-nuts, the imports being derived chiefly from Java, Sumatra and China, whilst the exports, which are smaller than the imports, are sent chiefly to Eastern countries.

In the British leased territory of Weihaiwei, in the Chinese Province of Shantung, there is a small production of ground-nuts and a re-export trade in ground-nuts and ground-nut oil produced in Chinese territory, these products being now the principal articles of trade in the Territory. Up to the year 1914 the principal market for these articles was Hamburg, but now nearly all the exports go to Hong Kong for re-distribution. Hong Kong also takes a considerable share in the distribution of ground-nuts produced in China. The imports of ground-nuts into Hong Kong are chiefly derived from North China, whilst the exports are sent chiefly to ports in South China. There is also a considerable export of ground-nut oil from Hong Kong, amounting to 11,134 tons in 1923, valued at £492,837. The oil is obtained mainly from North and Central China, and is re-exported chiefly to Eastern countries and also to the United States, Canada and Australia.

In Iraq (Mesopotamia) experimental plots of ground-nuts have been grown at Felliyah during recent years, and have given satisfactory results. As there is a considerable local demand for the nuts for edible purposes, there would seem to be good reason for increasing the output. The nuts are consumed locally in a parched state, or are used in confectionery. The variety grown at Felliyah was the "Small Japanese," which has a bright red pellicle, is quick growing and easy to harvest, and is reported as requiring but little water.

Africa

The ground-nut is grown in various parts of Africa, but it is of most importance on the West Coast, especially in French Senegal and the British possessions of the Gambia and Nigeria. The West Coast of Africa, together with India, furnish the bulk of the supply of ground-nuts imported into European countries. The cultivation of the ground-nut in West Africa is entirely a native industry, and for the most part is carried on by means of primitive hand implements. In view of the great and increasing demand for ground-nuts and the difficulty of obtaining sufficient native labour in some of the localities suited to the crop, it has been suggested from time to time that modern machines, such as are employed in the United States, might be used in West Africa for ground-nut cultivation. Apart from saving a great amount of manual labour, machines have the advantage of being able to cope with large areas in a short time, thereby enabling the cultivator to take advantage of the rains or other seasonal changes on which the various operations connected with ground-nut cultivation depend. In this connection trials have been made in Senegal during recent years by the Compagnie Française de l'Afrique Occidentale with American machinery, and these having proved successful indicate that it may be possible for Europeans to engage in the cultivation of the ground-nut should the native methods fail to maintain the necessary supplies.

In the Gambia the ground-nut is a crop of the first importance, as it is practically the only article of export. The nuts are grown entirely by native labour and chiefly by " strange farmers," or immigrants from French territory, who visit the Gambia annually for the sole purpose of raising ground-nuts, returning again to their own country after the crop has been harvested. Primitive implements (Plate VII) are employed, involving considerable hand-labour. The recently formed Agricultural Department is devoting attention to the crop, and in a Report by the Director for 1923 (see this BULLETIN, 1924, **22**, 478), proposals are made for inducing " strange farmers " to settle in the country in view of their declining numbers during recent years. The need for improved implements and for carefully selected seed is also pointed out, as well as for agricultural schools where actual demonstrations of improved methods of cultivation could be given. The number of " strange farmers " entering the country declined from 24,150 in 1920 to 20,566 in 1922, and the export of nuts has fallen somewhat during recent years as shown in the following table, which gives only the produce of the country :

1913. *tons.*	1919. *tons.*	1920. *tons.*	1921. *tons.*	1922. *tons.*	1923. *tons.*
67,404	70,290	84,037	58,274	62,978	62,564

The total exports from the Gambia in 1924, including re-exports, amounted to 60,622 tons. The nuts are exported from Bathurst (see Plate VI, fig. 1), where the principal European firms concerned have depôts at which the nuts intended for export are collected. The method of inspection for adulteration and impurities previously in force in the Gambia, having proved irksome to growers and ineffective in results, has been abandoned. Rotary screens have now been introduced by the Department of Agriculture (see Plate V, fig. 2), and the screening of nuts intended for export is compulsory. As a result the amount of impurity in shipments has been reduced from as much as 8·950 per cent. in 1924 to 0·393 per cent. in 1925.

In Nigeria the ground-nut has been used as a local food-crop from very early times, but it is only comparatively recently that an export trade in ground-nuts has been developed. This trade was made possible by the opening up of the Northern Provinces by railways which provided the necessary transport facilities to the coast. The chief centre of the trade is at Kano, 700 miles from the coast, and the crop is now grown largely for export, especially in the Northern Provinces and the drier parts of the Southern Provinces. It is said that this trade is capable of considerable expansion, the chief requirements for increased production being further railway transport facilities and remunerative prices. The nuts are exported in a decorticated condition in order to save freight. The work of decorticating is done chiefly by women by means of a pestle and mortar, the old-time method of hand-shelling, except for seed purposes, being now almost entirely abandoned. A woman can decorticate 20 lb. of nuts per hour with pestle and mortar, as against 14 lb. per day by hand-shelling, but although the former is the more expeditious method it is liable to damage a rather high percentage of kernels, and the need for introducing modern decorticating machines is obvious. In addition to the nuts produced in Nigeria, the exports include a considerable quantity brought into the country on pack animals from French territory. The exports in recent years were as follows :

1913. *tons.*	1919. *tons.*	1920. *tons.*	1921. *tons.*	1922. *tons.*	1923. *tons.*	1924. *tons.*
19,288	39,334	45,409	50,979	23,890	22,887	78,171

In the Gold Coast the ground-nut is extensively grown as a food-crop, but as the supply of nuts rarely exceeds the local demand there is seldom any surplus available for export. In the Trade Returns for 1922–23 an export of 28,320 lb. of ground-nuts appears for the first time. It is probable that there will not be any appreciable expansion in this trade until new lands are opened up, as at present the crop within the maritime provinces is merely a subsidiary one. Experiments have recently been carried out by the Department of Agriculture at Ejura in North Ashanti, which have proved that the ground-nut is a suitable crop for the open country of the interior, and that it gives satisfactory yields. There is no doubt that it could be produced abundantly and cheaply if railway transport facilities were available for conveying the produce to the coast, but pending the opening up of the country by railways further developments are not likely to ensue.

In the countries comprising East and Central Africa the ground-nut is grown as a local food-crop, and there is also an export trade in ground-nuts from East African ports, chiefly the produce of Tanganyika Territory and Portuguese East Africa. To the Portuguese the ground-nut is known as 'amendoim'; it is grown on a fairly large scale in the neighbourhood of Mozambique, and is exported through that port, and also from Lourenço Marques and Inhambane.

In Tanganyika Territory the cultivation of ground-nuts is entirely in the hands of the natives, and when the prices are sufficiently high to remunerate the grower the local surpluses are attracted to the ports from remote districts, and become available for export. The local conditions are well suited to the ground-nut, and there is ample room for a considerable extension of the cultivation, but before this can take place transport facilities must be provided to admit of the produce being exported. There are, however, possibilities of a greater production from existing areas of cultivation north and south of the central railway and from the area north of the River Kagera, and from Karagwe in Bukoba.

The exports of decorticated ground-nuts from Tanganyika Territory during recent years, compared with the exports for 1913, are as follows:

1913.	1920.	1921.	1922.	1923.	1924.
tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
8,961	3,238	8,448	12,518	16,508	18,684

The natives of Nyasaland cultivate the ground-nut extensively as a food-crop, and are said to recognise fully its special cultural requirements. There is, however, only a small surplus of nuts annually available for export, the quantity varying in accordance with the local demand and the price offered by exporters. The trade is chiefly in the hands of Indian traders (banyans) who purchase the nuts by barter from the natives and act as middlemen between the grower and exporter. Owing to the high freight charges, which are more favourable to tobacco and cotton, the ground-nut has not received much attention from planting companies, and is still almost entirely a native crop. It seems probable, therefore, that the best means of increasing the production would be to distribute to native growers seed of improved varieties and to guarantee a minimum price for the crop that would repay the grower. The yield from experimental plantings on various soils and at different altitudes has ranged from 200 lb. to 1,532 lb. per acre. The exports during recent years have been as follows :

1913–14,	1919.	1920,	1921.	1922.	1923.
tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
434	67	2½	nil	nil	2

The area under ground-nuts in Uganda in 1923 was 86,660 acres, the principal areas being in the Teso and Lango Districts of the Eastern Province, and the West Nile District of the Northern Province. The cultivation of ground-nuts is entirely a native industry and the greater part of the crop is consumed locally.

The following are the quantities exported from Uganda during recent years compared with the exports in 1913–14 :

1913–14.	1919–20.	1920.[1]	1921.	1922.	1923.
tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
383	56	6	2	506	175

[1] *Nine months only.*

In Kenya the ground-nut is grown by natives along the coastal area and there are indications that some attention is now being given to the crop for export purposes. The following table shows the quantity of ground-nuts exported from the Colony and Protectorate through the port of Mombasa :

1913–14.	1919–20.	1920–21.	1921–22.	1922–23.	1923–24.
tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
477	15	171	115	1,205	1,877

In the Sudan the ground-nut is cultivated chiefly in the Upper Nile and Kordofan Provinces, and is also grown in the White Nile, Fung and Kassala Provinces.

There has recently been a considerable development in the production of ground-nuts for export, partly due to a reduction in railway rates for the product. The area under ground-nut cultivation in 1923 was returned as about 20,000 acres, an increase of 5,000 acres over the area for 1922.

For the most part the crop is grown on rain lands, chiefly along the margins of rivers, as the infiltration of moisture from the rivers supplements the rainfall which, in the main rain-belt of cultivation, is too light for this crop. It is also grown under irrigation where suitable sandy loams are available, but much of the soil on pumping estates is too heavy for the purpose.

According to the Annual Report of the Commercial Intelligence Branch of the Sudan Central Economic Board for 1923–24, " discussions have taken place with the Chamber of Commerce as to the possibility of holding public auctions for ground-nuts in the chief centres in Kordofan Province, and it is hoped to carry out an experiment on those lines next season. If the trade develops, it will be worth while considering the provision of a decorticating plant. The best centre for this would probably be at Khartoum, as this would be available for the water-borne traffic from Jebelein on the White Nile, and also for the rail traffic on the Blue Nile districts." At present most of the export of Sudan ground-nuts goes to Egypt, but certain quantities have recently been sent to the United Kingdom and to Continental countries, and should the production be developed as anticipated, this export will no doubt increase.

The following figures show the quantities exported from the Sudan in recent years :

1913. *tons.*	1919. *tons.*	1920. *tons.*	1921. *tons.*	1922. *tons.*	1923. *tons.*	1924. *tons.*
719	3,498	2,846	4,203	2,695	6,028	10,417

It is probable that the countries in Africa where the ground-nut will in future be grown on a large scale on modern lines by European farmers are the Union of South Africa and Rhodesia. The crop has in the past been grown only by natives in those countries, but, in consequence of the higher prices and increased demand brought about during the war, ground-nuts have recently received a considerable amount of attention from Europeans. At present, however, the crop is usually regarded as of less importance than maize, and in consequence it receives less favourable attention. In Rhodesia the climatic conditions are said to be quite favourable to the ground-nut and large areas of suitable land for its extended cultivation are available.

Several varieties are in cultivation in Rhodesia, the highest yield being derived from "Spanish Bunch." The crop is remarkably free from disease and is only occasionally troubled with leaf-spot, which is kept in control by the use of Bordeaux mixture. The present production is usually not more than sufficient to supply the demands of the local oil-mills and of the labourers in the mines with whom ground-nuts form an important article of diet. Occasionally there is a small surplus for export which is usually sent to the Union of South Africa.

The area under ground-nuts in Southern Rhodesia in the season 1923-24 was 5,436 acres; the production during recent years has been as follows:

1914-15.	1918-19.	1919-20.	1920-21.	1921-22.	1922-23.
tons.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
397	402	629	1,350	1,008	1,200

In the Union of South Africa the ground-nut is being grown on an increasing scale, especially in the Transvaal, but cheaper transport facilities are essential before the exports can become large, and modern harvesting machinery must be employed to eliminate the present somewhat expensive method of harvesting by hand-labour. Ground-nuts are recommended as a suitable crop for rotating with cotton, sorghum and maize in South Africa, and on some soils are said to pay better than maize. According to *Farming in South Africa*, issued by the Department of Agriculture in Pretoria (Feb. 1924), " the high summer temperature of the 'middle veld' and 'low veld' are well suited to the crop, and there are hundreds of thousands of acres of soil in South Africa in areas which have already been shown to be naturally suited to the peanut crop. The main areas are in the Northern and Western Transvaal, parts of Natal and most of Zululand, and portions of the Eastern Cape Province."

The total production for the year 1922–23 was 5,261 tons. Although there is a small export from South Africa there is in reality no surplus available, as the quantity imported from neighbouring countries far exceeds the amount annually exported. The following figures show the exports of ground-nuts produced in the Union during recent years :

1913. *tons.*	1920. *tons.*	1921. *tons.*	1922. *tons.*	1923. *tons.*	1924. *tons.*
3½	26	88¾	11	2	13

Australasia

At the present time Australia is an importer of ground-nuts, the quantity imported during the fiscal year 1922–23 being, according to the Trade Returns, 1,447 tons, of which 1,328 tons came from China. Attempts have recently been made to supply the demand for ground-nuts, which are used chiefly for edible purposes, by locally-grown nuts, but owing to the wrong varieties having been cultivated and the nature of the soil, these attempts have not been altogether successful (see this BULLETIN, 1925, **23**, 68). The Australian crop is grown chiefly in the Northern Territory and in the northern part of New South Wales, and although good yields have been obtained, the red colour of the soil in these localities has proved detrimental to the appearance of the nuts. Where grown on light soils, however, the Australian nuts are equal in appearance to those imported. The varieties in demand are " White Spanish " and " White China," but the variety hitherto grown has been " Red Spanish." It is probable that, when further trials with different varieties have been carried out, a variety suited to local conditions as well as to local requirements will be found and the industry will become established on right lines. Meanwhile, in order to encourage the cultivation of ground-nuts in Australia, there is a protective tariff of 4*d.* per lb. on ground-nuts imported in the shell and 6*d.* per lb. on the kernels ; ground-nuts for the manufacture of oil are admitted free.

New Zealand is also an importer of ground-nuts, but the quantities entering that country cannot be stated as they are not separately recorded in the Trade Returns.

The imported nuts are obtained chiefly from China, Java and East Africa. As in the case of Australia the ground-nuts imported into New Zealand are used chiefly for edible purposes. From time to time reports have been published of the successful cultivation of small patches of ground-nuts in the North Island but, so far, ground-nuts have never been grown as a field crop in New Zealand.

In Fiji, ground-nuts are grown as a local food crop, the small Java variety being the kind chiefly employed for this purpose. The larger kinds, such as "Spanish," "Valencia," "Carolina" and "Chinese," have also been produced, and formerly these were grown on a fairly extensive scale for the Australian market, but the protective tariff referred to above has checked this trade. It has been suggested that Fiji might find an outlet in Canada for any surplus ground-nuts, as a considerable market exists there for the better kinds of nuts for confectionery and edible purposes. The following table shows the import of ground-nuts in shell and decorticated into Canada during recent years :

	1920. *tons.*	1921. *tons.*	1922. *tons.*	1923. *tons.*
In shell . . .	2,495	2,959	2,620	2,043
Decorticated . .	4,115	4,013	4,621	4,240

At present Canada obtains the bulk of her supplies of both decorticated and undecorticated nuts from the United States, and from Japan and China through Hong Kong.

Other Countries

In the West Indies the ground-nut is, generally speaking, only a minor crop, but in St. Vincent it is of some importance, and there is usually a small surplus available for export. The exports in 1923 amounted to 221 tons, of value £2,988. There is said to be a large portion of land in St. Vincent eminently suited to the ground-nut crop. During recent years the ground-nut has been grown experimentally in St. Kitts, Antigua and Montserrat, with satisfactory results, and trial consignments have been sent to Canada. These were reported as being unlikely to compete successfully with the nuts imported from the United States and China, which are large and of attractive appearance, having been subjected to a cleaning process before export. In view of the proximity of the Canadian market it would seem worth while for the West Indies to cultivate the kinds in demand there with a view to supplying a part, at least, of the Canadian demand.

In Cyprus the Agricultural Department have for many years grown ground-nuts experimentally, and have endeavoured to interest the local farmers in the crop. The result is that ground-nuts are now being grown by private enterprise, especially in the Kyrenia District, and a small export trade to Egypt is growing up. The nuts produced in Cyprus are said to be mostly superior in size, shape and flavour to those of Egypt, and there appears to be no reason why the crop should not be grown in many parts of the Island where the soil is of the right nature and where water is available.

In Mauritius, where the ground-nut is known as pistache, it is grown as a crop on a limited scale, chiefly by Indian cultivators, and is said to succeed in almost any part of the Island. Trial cultivation with a number of varieties of ground-nuts have been carried out during recent years at Réduit, Pamplemousses and Montagne Longue, the highest yields being obtained from varieties known as Madras, Mozambique, Senegal, F.M.S., Pondicherry, Virginian and Bunch, and these varieties are recommended for planting on an extended scale.

UTILISATION

For Human Consumption

Ground-nuts are largely used in the countries of origin as human food either in the raw state or roasted. Their high protein content makes them especially valuable as flesh and muscle formers. The native races use them in soups, and mixed with millet and rice in the preparation of various foods.

In the United States of America various methods of preparing the nuts as food are adopted ; in some they are blanched and salted, while in others they are mixed with syrup and made into candies, either alone or in combination with pop-corn and puffed rice. Sauces and milk substitutes are also made from the nuts. Ground-nut meal is often an ingredient in various confections. By far the greatest quantities of ground-nuts consumed as food in the United States, however, are eaten in the form of roasted nuts or as peanut butter. For the former purpose the Virginian variety is preferred on account of the large size and good flavour of the kernels. When undecorticated nuts are employed the roasting is carried out at 400° to 450° F. for about thirty minutes, kernels being roasted at a lower temperature, namely not above 320° F. The roasted kernels may be salted. The use of peanut butter is of comparatively recent origin, but has lately increased enormously, from six to eight million bushels of nuts being absorbed in this way in 1919. For the preparation of peanut butter a mixture of Spanish and Virginian kernels are generally employed, the former imparting smoothness and the latter flavour to the product. The kernels after being roasted are freed from the red skins and germs. These blanched kernels after being cleaned and hand-picked are mixed with salt and ground into a fine paste or " butter." The butter is packed in hermetically sealed tins and bottles and is then ready for sale.

In England ground-nuts are used to replace almonds in confectionery and sweetmeats, and in various nut-foods. In India they are extensively eaten roasted, and are also made into sweetmeats by being mixed with palmyra palm or sugar-cane jaggery.

Ground-Nut Oil

By far the greater part of the world's production of ground-nuts is used for the expression of oil. For a great many years Marseilles has been the chief centre of this industry, and large quantities of the nuts annually reach that port from various quarters of the world. Considerable quantities are also crushed in Holland, the United Kingdom, Spain, Italy and Germany. Of countries producing ground-nuts, India and the United States manufacture a large amount of oil, which is almost completely absorbed by the local markets. China, on the other hand, not only supplies its own large demand, but exports more oil than any other country. Considerable quantities are also shipped from Japan and the Dutch East Indies.

Preparation of Ground-Nut Oil

In most countries where ground-nuts are grown, oil is prepared from them by means of crude wedge presses or other native methods. Such oil is, however, generally only employed for local use. The question of preparing ground-nut oil on a large scale in the countries of production by modern machinery has been repeatedly considered, but, with the exception of the United States, in none of these countries has oil-crushing on a large scale been started. Local extraction has the advantages that the oil can be prepared from nuts in a fresh condition, freight charges are lessened, and the residual cake becomes available for local use. On the other hand, European users prefer to have their oil prepared in European mills where expert supervision and highly-skilled labour are available, whereby, they consider, a better product is obtained.

When working with unshelled nuts the first step in the process, after screening to separate sand and dirt, is the removal of the outer husk, though sometimes undecorticated nuts are directly expressed for oil. This decortication is usually effected by means of a machine, known as the " huller." This may consist of a cylinder, the lower half of which is made of steel bars properly spaced, having inside rough-faced discs, some revolving and others stationary, placed side by side so that the revolving discs alternate with the stationary ones. The hulls of the ground-nuts, which are fed in at the top, are rubbed off as they pass between the discs, and the hulls and kernels pass out through the slits between the bars beneath. Small machines worked by hand are also available, which are specially suitable for use in the Colonies. The general principle upon which these machines work is the breaking of the husks between rollers, set at such a distance as to effect this without crushing the kernels. After passing through the huller, the husks and as much as possible of the red skins are removed by means of sieves and a blast of air, or by suction. In some mills the germs are removed, as their elimination is considered to improve the quality of the oil. The husks are usually burnt as fuel, but are sometimes mixed with meal and made into oil-cakes, while the red skins are added to refuse meal and pressed, but they are said to impart an unpleasant acrid taste to the resulting cake. The cleaned kernels are ground between rollers and then submitted to expression in hydraulic presses, being generally pressed two or three times in succession.

The first pressing takes place at the ordinary temperature, and on account of the pasty nature of the ground mass, which causes it to ooze through the press-bags or cloths generally employed in oil-crushing, modern installations employ " cage " or " clodding " presses. Such a press is composed of a perforated metal cylinder, or of a circle of stout, flat, metal staves, surrounded by strong metal rings. The ground meal is packed between metal plates and the use of press-cloths or bags is unnecessary. By the first expression in the cold, kernels of good quality may yield as much as 30 per cent. of pale-coloured oil, having an agreeable nut-like flavour ; this cold-drawn oil is known as " huile surfine " de Rufisque, Gambia, etc., according to the origin of the nuts used in its preparation, and is largely employed for edible purposes.

This first cake is then broken up, moistened and warmed in steam kettles to a temperature of 30° to 32° C., and submitted to a second expression, when a further 6 or 8 per cent. of oil is obtained, which is inferior in quality to the first, but still suitable for edible use. In some cases the second expression is carried out at ordinary temperature. In cases where a third expression is made, the temperature is increased to 50°–55° C., and from 5 to 7 per cent. more oil is obtained, which is unfit for edible use and is generally made into soap. The second and third expressions are usually made in open Anglo-American or Marseilles presses, which employ cloths or bags to hold the cake.

Of recent years " expellers " have been in use in the

United States for crushing ground-nuts. In this process the nuts are not subjected to cooking, but are chopped and heated to some extent in a steam-heated conveyor which carries the material to the expeller. Usually the husks are not removed, but remain in the cake, but in some mills the nuts are decorticated first, whereby a virgin oil is obtained that needs no refining but is merely filtered.

The following table shows the oil-content of the different kinds of ground-nuts and the approximate yields obtained on crushing in oil-mills :

Kind.	Percentage of Shell in Nuts.	Oil-content of		Yield of Oil on crushing.	
		Undecorticated Nuts.	Decorticated Nuts.	Undecorticated Nuts.	Decorticated Nuts.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Rufisque . Saloum . Sine . Gambia .	28–30	35–36	50–51	31·5–32·5	44·5–45·5
Casamance .	30–32	34–35	50	30·5–31·5	—
Bombay . Coromandel	—	—	42–44	—	36–38
Mozambique .	—	—	46–48	—	40–42
La Plata . .	—	—	—	27·5–28	—
American : Spanish .	21–25	37·5–39·5	50	—	—
American : Virginian .	28–30	29–30	41·7	—	—

Generally speaking, it is only from the best grades of ground-nuts, e.g. Rufisque, Cayor, Sine, Gambia, etc., shipped in their husks, that the finest qualities of oil suitable for edible purposes can be prepared ; such grades as are shipped in a decorticated condition, e.g. Bombay, Coromandel and Mozambique, undergo changes, which render the oil obtained from them of unpleasant taste, whilst the cakes are also slightly inferior.

In the United States the true Spanish variety is the one usually grown for the production of oil, as the kernels have a higher oil-content than those of any other variety, with the possible exception of Valencia or Tennessee Red, both of which are of the Spanish type. It also has a higher percentage of kernels than any other variety grown in that country.

The oil-content is stated to depend on the richness of the soil and the conditions of cultivation rather than on the variety grown, the percentage of oil also being greater in nuts grown in warm climates than in those grown in temperate ones.

Characters of Ground-Nut Oil

Ground-nut oil is a non-drying oil, having the following average constants:

Specific gravity at 15/15° C.		0·916–0·918
Acid value		below 20
Saponification value		190–196
Iodine value	*per cent.*	87–98
Unsaponifiable matter	,,	0·4–0·8
Refractive index at 40° C.		1·4626–1·4643
Solidifying point of fatty acids °C.		28·1–29·2

The oil consists chiefly of the glycerides of oleic and linolic acids with smaller amounts of those of palmitic, stearic, arachidic and lignoceric acids. Ground-nut oil is a golden-yellow oil, liquid at ordinary temperatures, with a pleasant nutty taste and odour. If necessary it can be refined in the usual manner with soda and deodourised with steam. Its principal use is as an edible oil, especially as a salad oil in place of olive oil. It is often blended with some grades of olive oil to reduce the harsh taste. For edible use it is frequently decolourised by means of fuller's earth or charcoal. Considerable quantities are hydrogenated to produce a hardened fat which is employed in the manufacture of margarine and other edible fats. Ground-nut oil also finds a use as an illuminant and lubricant, and for oiling wool. The lower qualities are employed for soap-making. As already indicated, the cold-drawn oil from high-grade nuts is the most suitable for edible purposes though sometimes oil from the second pressing is used. Ground-nut oil appears among the official oils in the British Pharmacopœia and may be employed in place of olive oil in India, Africa and Australia in making certain official preparations. The oil has also been successfully used as a fuel in Diesel engines.

By-Products of Ground-Nut Milling

Ground-Nut Cake.—The residual cake left after the expression of the oil from the nuts or kernels forms a valuable concentrated feeding-stuff for cattle and other farm animals. The following are typical analyses of the cake compared with other feeding-cakes in common use (Smetham, *Journ. Royal Lancashire Agric. Soc.*, 1914).

—	Ground-nut cake.		Cotton seed cake.		Linseed cake.	Soya Bean cake.
	Decorticated.	Undecorticated.	Decorticated.	Undecorticated.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	8·25	10·10	7·40	13·75	11·16	12·70
Crude Proteins	48·00	28·50	42·37	24·62	29·50	38·82
Fat	5·53	9·33	10·16	6·56	9·50	11·07
Carbohydrates, etc.	28·35	25·20	25·86	29·28	35·54	26·51
Crude Fibre	1·67	22·47	7·06	21·19	9·10	5·85
Ash	8·20	4·40	7·15	4·60	5·20	5·05
Nutrient Ratio	1 : 0·9	1 : 1·6	1 : 1·2	1 : 1·8	1 : 1·9	1 : 1·3
Food Units	162	120	157	107	133	151

Ground-nut cake contains a higher percentage of protein and of oil and protein combined than any other oil-cake and is, moreover, more easily digested. As a result of cattle-feeding experiments conducted at the Woburn Experimental Farm it is stated that ground-nut cake is about equal in feeding value to beans. It also has the advantage over the nuts themselves that it does not produce soft pork when fed to hogs.

Trials made in Bombay have shown that the decorticated cake when mixed with cereals is suitable for human consumption, but the red skins should be removed from the kernels before crushing. Biscuits made from the meal from blanched kernels and maize meal have been manufactured, and an attempt made to put them on the London market. Ground-nut flour made from the decorticated cake or from roasted or raw nuts is now on the market in some countries.

Cake which is unsuitable for feeding to animals finds an extensive use as a manure, particularly in the intensive market gardens of Southern France.

Husks.—These are generally burnt and the ashes, which often contain 3 per cent. of phosphoric acid, 9 per cent. of potash and 6 per cent. of lime, are used as a fertiliser. They are sometimes used as a litter for cattle, for mixing with ground-nut meal, or as an absorbent medium in making cattle foods, with molasses as a basis. Trials have been made with the husks as a paper-making material and have shown that they are of little value for the purpose and only suitable at the best for low-grade card. They have also been employed as a substitute for powdered cork for insulating purposes, but their value is

30 per cent. lower. Alcohol and acetone can be produced from the husks by fermentation of the hydrolysed material.

Red Skins.—As separated from the kernels in the preparation of peanut butter and in the process preliminary to crushing, the red skins or seed-coats contain about 14 per cent. of oil. In Germany they are mixed with varying proportions of ground husks and the product is then known as ground-nut bran. The red skins have a nutritive value almost equal to that of wheat bran, and are especially desirable for mixing with broken peas for stock-breeding and for increasing the milk production of dairy cows. They are also used as litter.

Germs.—In the preparation of peanut butter and sometimes before crushing the kernels, the germs are removed, as their presence, especially in the former case, has a bad effect on the quality of the butter. These germs are useful as a feeding-stuff, being largely used for feeding to hogs. They contain about 30 per cent. of protein. Care should be taken, however, to give them in moderation and in combination with some grain, as when fed alone they produce in hogs flesh lacking in firmness and a soft, oily lard. The germs are also used in cattle foods and for feeding to poultry.

The following analyses show the relative values of various ground-nut products for feeding stock or as fertilisers. The corresponding figures for clover hay, meadow hay and lucerne are added for comparison :

Ground-nut.	Moisture.	Calculated on the dry substance.					
		Ash.	Protein.	Oil.	Crude Fibre.	Carbo-hydrates.	Total nitrogen.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Whole plant . .	—	—	18·40	21·50	—	40·10	—
Leaves and stems, green	77·10	7·05	16·00	4·27	20·11	50·01	2·56
Leaves and stems cut before flowering .	31·20	10·64	12·63	6·07	22·32	48·34	2·02
Leaves and stems cut after ripening of fruit.	31·91	12·08	10·81	5·02	32·28	39·81	1·73
Hay	7·83	17·04	11·75	1·84	22·11	46·95	1·88
Husks. . . .	12·94	3·39	7·22	2·68	67·29	19·42	1·17
Red skins, removed by hand, Spanish variety	9·3	3·3	14·0	5·0	12·4	65·3	—
Germs. . . .	5·6	3·3	30·8	48·4	4·8	12·7	—
Clover hay . . .	14·30	7·47	12·84	2·11	29·27	48·31	—
Meadow hay (good quality) . . .	15·0	8·2	13·8	2·6	25·8	49·6	—
Lucerne . . .	6·95	7·49	16·48	2·03	31·38	42·62	—

NIGERIA: ITS DEVELOPMENT AND RESOURCES

In his farewell address to the Legislative Assembly of Nigeria in February of the present year, the late Governor, Sir Hugh Clifford, G.C.M.G. (now Governor of Ceylon), reviewed the progress which had recently been made in the country notwithstanding many economic and other difficulties, and indicated the high state of efficiency which now characterises the Government Departments. This Address and the retirement of Sir Hugh Clifford from the Governorship coincide with the completion of twenty-five years of Crown Colony administration in Nigeria, since it was in 1900 that the Colonial Office assumed control and the Protectorates of Northern and Southern Nigeria were proclaimed; and the occasion seems appropriate for the publication of a short account of the history, development and present condition of this important British possession.

The name Nigeria is a relatively modern one in the history of British West Africa, and as now used, without any prefix such as Northern or Southern, it has only been official since 1914, when the two distinct administrations previously existing were fused into one, and the area they covered became a self-contained unit under the title of the Colony and Protectorate of Nigeria.

I. GENERAL

Nigeria consists of (*a*) the "Colony," which is merely a small area of 1,400 square miles in the south-west but includes Lagos, the administrative capital of the country, and (*b*) the Northern and Southern Provinces which together form the Protectorate. For purposes of administration the Protectorate also includes the portion (about 31,000 square miles) of the former German Cameroons mandated to Great Britain by the League of Nations—the greater part of the Cameroons having been placed under the ægis of France. The country is, in fact, now entirely bounded on its land frontiers by territories under French rule. The total administrative area is about 368,000 square miles, which is slightly less than that of Tanganyika Territory, whilst in population Nigeria is by far the largest of the British Dependencies with the exception of India, the native inhabitants being estimated to number some 18¾ millions.

The Protectorate is divided into Provinces, each of which is in charge of a British Resident with his subordinate officers. A large amount of local administrative work is, however, delegated to paramount chiefs and other native officials. The present condition of the country would indeed have been unattainable without organised native co-operation, not only in political administration but in the Government service generally. The white population only amounts to some 4,000, and the great majority of railway, postal and other officials are drawn from African sources.

The inhabitants of Nigeria consist of numerous tribes and peoples differing widely in origin, language, civilisation and general characters. In the Southern Provinces the principal elements are pagan races of pure negro stock, of which the most important are the Yorubas, Ibos and Benis. In the northern part of the country, on the other hand, the chief races are of Berber or negroid origin and include the Fulani, Kanuri and Hausas. The majority of this northern population are adherents of Islam. It is estimated that of the smaller tribes of Nigeria there are no less than a hundred in the mountainous country of the Bauchi plateau in the Northern Provinces, and a similar number in the Southern Provinces in the district between the River Benue and the sea. The diversity of these lesser communities is a great hindrance to efficient administration in such areas.

II. HISTORY

As in the case of many other regions which eventually came under British rule, Portuguese explorers were the first to make this part of West Africa known to Europe. For a long period after its discovery the coastal region was used by various nations as a source of slave labour for the New World, until in the early part of last century Great Britain decided not only to end the traffic so far as she was concerned, but also to obstruct the exploitation of the natives by slave raiders of other nationalities. The trade in slaves still went on to some extent, largely with the connivance and assistance of native chiefs who found it profitable to exploit the weaker tribes in this way; but, as it diminished, the exportation of ordinary products (such as palm oil) began to be fostered, and the modern economic history of Nigeria may be said to have commenced about the middle of the century. At this time the development of the country was greatly assisted by the activities of various explorers, who went into the interior and gradually opened many parts of it to legitimate trade. In 1879 the Royal Niger Company received its charter from the British Government and was made responsible, in theory at least, for the administration of a large area, including parts of what is now the Northern Provinces. In 1885, by the decisions of the Conference of Berlin, British control was recognised over Lagos and other parts of the coastal region, and an administration known as the Oil Rivers Protectorate was established.

The Royal Niger Company was unable to exercise satisfactory control over the more turbulent tribes in its area, or to resist foreign aggression in a suitable manner, and it was found necessary in 1900 to revoke the Charter and to form the two official Protectorates of Northern and Southern Nigeria, which (together with Lagos) were placed, as already mentioned, under the Colonial Office. This step may be said to have inaugurated the effective sway of Great Britain over the territory of Nigeria as it now exists, and certainly marked a very important epoch in its development. As previously stated it was followed in 1914 by the amalgamation of the two Protectorates, most of the Government Departments being at the same time unified and the entire region placed under the control of Sir Frederick Lugard, G.C.M.G., who had been intimately associated with the country for many years and who was given the personal title of Governor-General. The present Governor of Nigeria is Sir Graeme Thomson, K.C.B., lately Governor of British Guiana.

Under the new conditions thus established in 1900 and 1914 the country has progressed in a remarkable manner, and in spite of the great diversity of race and language existing among its peoples it has in the main been peaceful, this state of affairs contrasting notably with the condition of strife between native tribes, and between natives and Europeans, which previously prevailed. A writer in the official publication *Nigeria : Its History and Products* (issued in connection with the British Empire Exhibition, 1924, and from which much information has been drawn for the present article) aptly refers to the progress of the country in recent years as reading " more like an extract from a book of fiction than a record of solid fact."

III. PHYSIOGRAPHY

Nigeria may be conveniently described as consisting of four zones, differing widely in natural features, viz. : (1) a coastal belt of low-lying country, varying in width from 10 to 60 miles, largely covered with swamps and mangrove forests and intersected by numerous creeks, lagoons and rivers, especially in the delta of the River Niger ; (2) a zone of undulating and thickly-wooded country, from 50 to 100 miles wide, well-watered and abounding in oil-palms as well as timber trees ; (3) further inland, a more elevated, park-like region, which on the Cameroons border rises into mountains of considerable altitude ; and (4) behind this, a vast region occupying the greater part of the Northern Provinces and consisting in the main of an undulating plateau, bearing thin savannah forests over much of its area, but merging (towards the Sahara and the Western Sudan) into actual desert. Many rivers have their source in this immense northern region, but its general elevation is not much over 2,000 feet, except in Bauchi Province where there are mountains some 6,000 feet high.

The River Niger, which gives its name to the country, rises far to the westward, on the borders of Liberia and Sierra Leone, and for the greater part of its course flows through French territory. It then enters Nigeria from the north-west, in Sokoto Province, flowing thence in a south-easterly and southerly direction for several hundred miles to its delta in the extreme south of the country. Next to the Niger the principal river in Nigeria is the Benue, which enters the country from the Cameroons near Yola, and after a southerly and westerly course of some 500 miles joins the Niger at the important town of Lokoja in Kabba Province.

The climate of Nigeria varies greatly, in accordance with the situation and physical features of the various regions. This is illustrated by the rainfall, the figures for which in 1923 were as follows:—At Bonny, on the coast, 151 in.; at Kaduna, the capital of the Northern Provinces, 43 in.; and at Maidugari, in the extreme north-east, about 26 in. From the point of view of health, improvement is gradually being effected by the clearing of swamps, the better drainage of the larger towns, the diffusion of hygienic knowledge, and in other ways, to the advantage both of Europeans and natives; but progress is of necessity slow, and in sanitary matters in particular the operations of the official Medical Staff have to be confined mainly to the large centres of population.

IV. Resources and Trade

Nigeria is a country of immense natural resources, and of vast possibilities as a source of cultivable products in particular. The large native population involves the local consumption of a very considerable proportion of the foodstuffs produced in the country, but it furnishes labour for the exploitation of minerals, the construction of harbours, roads and railways, and other work of economic importance, and consisting as it does largely of peasant farmers it is at the same time a guarantee that with proper organisation there should be an extremely large field for further enterprise in the production, preparation and shipment not only of oil-palm products, but also of cotton, ground-nuts, cocoa, grain, hides and other commodities of value in Europe. The forests, which cover a total area of some 220,000 square miles, are also in great part an asset of potential economic value.

The Government, with its well-equipped Agricultural and Forestry Departments, is doing much to assist and foster trade, and the general advance in recent years may be indicated by the following figures for certain of the principal exports:

	In 1900. Tons.	In 1913. Tons.	In 1924. Tons.
Palm oil . . .	45,508	83,089	127,013
Palm kernels . .	85,624	174,718	252,920
Ground-nuts . .	599	19,288	78,171
Cocoa . . .	202	3,621	37,192

These particular products have thus been exported in quantity for many years, but more recently certain other items have assumed importance in the returns, one of these being cotton, of which only 215 cwts. was exported in 1900, but no less than 92,786 cwts. in 1924. The total value of the Nigerian produce exported rose under pre-war conditions from £1,858,091 in 1900 to £6,779,205 in 1913, whilst in 1924 it was £14,427,727.

The revenue of the country, which has now for some considerable time been self-supporting, amounted in the financial year 1923–24 to £6,260,561.

In the agricultural development of Nigeria much will depend on the more extensive employment of machinery by trading firms, and the establishment of central depôts and factories to which the farmers can send their produce. The Government is doing all in its power to increase traffic facilities, and its Agricultural Department is carrying out a great deal of work in the encouragement and instruction of farmers, the selection of suitable seed for crops, the issuing of regulations, and the exercise of general supervision ; but any large-scale establishment of trading factories in the near future must depend in the main on private enterprise. The opinion has been expressed that "the best agency for taking up such pioneering work would seem to be some association of commercial interests working in close co-operation with Government." This, in effect, merely means the extension of a principle already adopted by the British Cotton Growing Association as regards cotton, and by some of the more enterprising trading firms interested in other commodities.

Timber has figured in the export returns for a considerable period, but the development of this trade depends largely on the policy of Government as regards the forests. The need for preserving them, and the impossibility in some regions of arranging this without long and troublesome negotiations with the native chiefs, makes the question difficult, but reserves to the extent of 5,500 square miles have already been established, and the delimitation of further areas is being actively pursued. A number of Nigerian timbers have been tested at the Imperial Institute, and the results of some of the work have been published in this BULLETIN (1920, **18**, 199; 1923, **21**, 444).

Cattle-raising, which is of special importance in the Northern Provinces, is also one of the subjects to which the authorities are paying much attention.

As regards minerals, which give a more immediate (if not always permanent) return on invested capital, much has already been done to develop the resources of the country, but here again, under the conditions prevailing, it is necessary for the authorities to retain full control, and to permit only such private enterprise as seems desirable. Certain minerals of economic value, particularly iron ore, have long been worked by the natives, but the sources thus utilised are not always, in quality or situation, worth the attention of prospectors, and a great step forward was taken in 1903–4, when, in conjunction with the Imperial Institute, the Mineral Surveys of Northern and Southern Nigeria were arranged. The work of the Surveyors, detailed results of which are available in a special series of Colonial Reports (obtainable from H.M. Stationery Office), proved the existence of many useful deposits, some of which only awaited the establishment of proper communications to render their exploitation possible. Among these were the now well-known Bauchi tin deposits, the so-called Udi-Okana coalfield, and the lignites of the lower Niger valley.

The Bauchi tinstone is worked by private companies and syndicates, whose operations gave employment in 1924 to some 20,000 natives. The quantity of ore exported since 1914 has averaged about 7,600 tons annually, and in 1917 the shipments amounted to nearly 10,000 tons. Gold is now being worked to some extent, the output in 1924 being 1,415 oz., against 956 oz. in 1923.

The coal and lignite have been the subject of special investigation at the Imperial Institute, and the results of the work have been published in this BULLETIN (1916, **14**, 369; 1923, **21**, 325). The lignite is not being worked at present, but the coal deposits were opened up by Government during the war and already form a valuable source of fuel for the Nigerian railways and steamers, whilst a certain quantity of the coal is available for sale. The work has been extended so rapidly that in the year 1924 the output was 201,932 tons.

The Mineral Surveys mentioned above came to an end before the war, but their place was taken in 1919 by a Geological Survey, which has since been engaged in investigating the mineral resources of the country from both a scientific and an economic standpoint.

V. COMMUNICATIONS, ETC.

Since the beginning of the present century the establishment of adequate communications of all kinds has received the constant attention of Government. Apart from the efficient postal, telegraph and telephone services, which are being continually improved and extended, some 1,200 miles of railway and several thousand miles of modern roads are now open for traffic, and an extensive service of steamers is in operation on the inland waterways. A considerable further mileage of roads and railways is under construction or in contemplation, and motor services have been established in many directions to facilitate the marketing of produce and the general extension of trade within the country.

The Western Division of the Nigerian Railway includes a main line over 700 miles long, running from Iddo (Lagos) to Kano (not far from the northern frontier of the country) and serving the important towns of Abeokuta, Ibadan, Oshogbo, Ilorin, Minna, Kaduna and Zaria. This line crosses the River Niger at Jebba. From Zaria a narrow-gauge branch, 143 miles in length, runs to Bukuru in the Bauchi tinfields, and another important branch is that from Minna to Baro, a distance of 111 miles. The Eastern Division, as at present completed, consists of a line which runs for 300 miles from Port Harcourt, through the coal-bearing district, to the Benue River, and is being extended northwards to join the Western line at Kakuri, 563 miles from Port Harcourt. On this route the Benue will be crossed by means of a train ferry.

In the twelve months ended March 1924 the Nigerian railways carried some 1,860,000 passengers and over 640,000 tons of goods and minerals, the gross receipts amounting to £1,653,115. There are now 151 stations open for traffic, 15 of which were added in 1924.

The construction of the railways has involved much engineering work of a high order, among the most notable examples being the two bridges by which the River Niger is crossed at Jebba, comprising in all eleven spans of a total length of about 1,900 ft. On its way to this point from the coast the line reaches an altitude of 1,400 ft. about 250 miles from Lagos, but this elevation is much exceeded further north. At Zaria the main line reaches 2,140 feet, and at one point on the Bauchi branch an altitude of over 4,400 ft. is attained

Road construction has also necessitated the building of many large bridges, and numerous primitive structures of " bamboo " and other unsubstantial materials are being replaced by timber or steel bridges supported by concrete and masonry. Mention must also be made of the continual progress in the provision of up-to-date dockyard accommodation at the ports, and the establishment of new harbour facilities, such as those at Port Harcourt which were designed to meet the special requirements of the Udi coal traffic. Much enterprise is also being shown in the laying out of towns and the erection of substantial buildings both for residential and commercial purposes. Kaduna, the capital of the Northern Provinces, is looked upon as a model of modern tropical town-planning. Lagos is notable for recent developments in the use of electric light and power, and for its supply of pure water from the Iju Valley, 17 miles away, of which there is already a consumption of ten million gallons weekly.

VI. EDUCATION

As Nigeria is a country in which industrial and commercial progress can only be ensured by enlisting the effective co-operation of the native population, the question of education is of the utmost importance from a utilitarian standpoint, apart from its bearing on the general welfare of the people. It was not found possible, however, to establish any official Education Department till 1910, and until that time the activity of Government in this direction had to be confined to the assistance of Mission schools and to certain other limited efforts, which, however, included the establishment of a Government school at Kano. Up to the present time the Northern educational administration has remained separate from that of the Southern Provinces, owing to the great differences existing between the peoples of the two regions and the consequent need for distinct methods.

The demand for education is now so widespread that it is practically impossible for the Government or other bodies to deal with it in a satisfactory manner. Ampler funds and a much larger supply of competent teachers are required to cope with the problem, but great progress is nevertheless being made, and many efficient schools are in operation. A training college for native teachers was opened in 1922 at Katsina. In 1923 there were about forty Government schools in the Northern Provinces, and a similar number in the Southern Provinces, in spite of the fact that progress had been hindered during the war period by the removal of a number of the principal officers. In both Northern and Southern Provinces are also numerous Mission schools, some assisted and inspected by Government, and others unassisted ; most of the rural schools being in the latter class.

The largest school in Nigeria is one under missionary auspices at Calabar, which in a recent year was employing 55 teachers and had an average daily attendance of over 1,300 children. At the same place there is an institutional school with some 220 boarders and 600 day pupils, whilst at Lagos the Government maintains a secondary school with 150 boys, staffed by four European and five African masters.

In all educational efforts in Nigeria due regard is paid to technical instruction, and many of the qualified pupils find employment in the railway, postal, marine, medical and other services of the Government.

From all that has been said it will be seen that a long period of continual progress should lie before Nigeria, and that with the further extension of means of communication, the opening up of new areas to commercial enterprise, and the spread of general and technical education, the country's vast resources may be expected to form an increasingly important asset to the Empire.

NOTES

Cotton Industry of India.—An account of the progress which is being made in India in connection with the improvement of the cotton crop is given in the *Review of Agricultural Operations in India*, 1923–24.

The area devoted to cotton-growing in that year amounted to 23,088,000 acres as compared with 21,792,000 acres in 1922–23 and 18,436,000 acres in 1921–22. The average yield per acre was 88 lb., as against 97 lb. in the preceding year and 67 lb. in 1921–22. The quantity of raw cotton exported was 3,008,000 bales during the year ending March 31, 1924, as compared with 2,690,000 and 2,981,000 in the years 1922–23 and 1921–22 respectively. The amount taken by English spinners increased from 67,000 bales for the year ending July 1922 to 176,000 bales for 1923 and 257,000 bales for 1924, much of which consisted of the superior varieties which the Agricultural Departments are endeavouring to establish in suitable areas. It is to be regretted that the efforts to establish these improved cottons on the markets were hindered to some extent by the export of adulterated and mixed cotton, but it is satisfactory to note that the Indian Central Cotton Committee has been devoting special attention to the improvement of marketing and the checking of adulteration.

The Cotton Transport Act was passed during the winter of 1922–23 with the object of preventing abuses which have tended to lower the reputation and value of Indian cotton. It enables Local Governments to establish definite areas for protection and to prohibit the importation of cotton into such areas except under licence. Licences are only granted to meet genuine trade requirements, and particularly to supply the needs of the cotton spinning mills situated within a protected area. The Act thus prevents short-stapled cotton, waste, and stained cotton from being transported for mixing purposes to areas producing long-stapled cotton, and in this way assists the Agricultural Departments in the endeavour to establish superior and uniform types over large areas. The Act. was enforced during 1923–24 in the greater part of the long-stapled cotton areas of the Bombay Presidency, and has effected a marked improvement in the quality of Surat, Dharwar and Kumpta cottons.

In Baroda, the cotton-growing areas adjacent to those of the Gujerat Division of Bombay have been similarly protected by a law on the lines of the Indian Cotton Transport Act and zones have been notified corresponding with those notified by the Bombay Government. The co-operation of the Baroda State in this direction is much appreciated.

A scheme is in progress for conducting research work on cotton at the new Institute of Plant Industry, situated at Indore, where an excellent site of 300 acres has been provided by the Indore Durbar for the Institute and farm. Mr. and Mrs. Albert Howard have been appointed as Director and Botanist respectively, and entered on their duties in 1924. The Institute is being financed partly by the Indian Central Cotton Committee and partly by the Central Indian States.

The Indian Central Cotton Committee are also financing special research schemes, including investigations on cotton wilt and boll- and bud-shedding, on the spotted boll-worm in Bombay, on the *Gossypium herbaceum* constituent of Northerns cotton in Madras, and on the pink boll-worm in the United Provinces. They have made grants for the appointment of a botanist to study the cottons of Berar and the Central Provinces with a view to the improvement of the staple, and are also providing a botanist for the Punjab to deal with the special problems arising in connection with the introduction of acclimatised long-stapled American cotton under canal irrigation. The Committee's Technological Laboratory in Bombay has been completed and equipped, and, in December 1924, the Viceroy formally opened the Spinning Laboratory and laid the foundation stone of the Research Laboratory.

Bombay.—In the Karnatak, 1½ million acres are devoted to cotton, about two-thirds of which are planted with Kumpta cotton and the remainder with Dharwar-American. The Agricultural Department's improved strain of Kumpta (Dharwar No. 1) was sown on 75,000 acres, and the improved type of Dharwar-American (Gadag No. 1) on 65,000 acres. These two new strains have increased the cultivators' profits by Rs.5 and Rs.13 per acre respectively. A promising hybrid between Kumpta and Roseum cotton has been produced which gives a lint of good colour and a length of 1 in. A cross between Kumpta and Wagale (a Burmese type) is of special promise as it shows signs of being wilt-resistant.

In Gujerat, great progress has been made with an improved strain of Surat, known as 1027 A.L.F., which is now being grown extensively. The Agricultural Department is aiming at the establishment of this as the sole variety to be grown south of the Narbada, thus excluding the production of shorter-stapled cottons. The Department now controls 9,000 acres of special seed-farms, producing 1¾ million lb. of seed. In the area north of the Narbada it is necessary to produce an improved cotton of higher ginning percentage than the existing departmental strains in order to replace the short-stapled Broach types now grown, and a promising form is being developed on the Surat farm.

In the Dholleras tract, several pure types of Wagad cotton have been evolved, and are now being multiplied at Viramgaon.

In Khandesh, seed distribution has been limited to the N.R. (*G. neglectum* var. *roseum*) type. A promising hybrid between Bani (*G. indicum*) and Comilla (*G. cernuum*) has been produced.

In Sind, the prospect of perennial irrigation on the completion of the Lloyd Barrage canal scheme has led to an entire revision of policy with regard to cotton-growing, and it is probable that this will become one of the most important long-stapled cotton tracts in India.

Madras.—The efforts to promote the cultivation of improved types of Cambodia, Karunganni, Northerns and Westerns has been continued (compare this BULLETIN, 1923, **21**, 520). An area of 72,000 acres was sown with an improved type of Karunganni; 20,500 acres were planted with Nandyal 14 (a selected Northerns cotton) as compared with 8,500 acres under this type in 1922–23; and 81,000 acres were sown with Hagari 25 (a selected Westerns type) as against 13,000 acres in 1922–23. The area devoted to irrigated Cambodia cotton amounted to 204,110 acres, the estimated yield being 119,000 bales. The improved strain, Cambodia 295, is being steadily extended in the Coimbatore District with the aid of private seed-farms. Several new promising strains of Cambodia have been isolated, and encouraging results have been obtained with crosses between *G. indicum* and *G. roseum* and between *G. indicum* and *G. cernuum*.

Progress has been made in the organisation of seed-farms for producing seed of improved strains, and the farmers are being persuaded to gin the seed-cotton co-operatively, whilst the Agricultural Department organises the ginning arrangements and purchases the seed.

Owing to an agitation on the part of the farmers, the time permitted under the Madras Pest Act for the removal of old cotton plants has been extended during the 1922–23 and 1923–24 seasons with the result that the minimum period of two months between the uprooting of the old plants and the sowing of the new crop is not obtained. This is stated to have had a bad effect, insect pests having multiplied to such an extent that the improvement effected in the cotton between 1919 and 1922 is now disappearing, particularly in the case of the Cambodia variety.

Punjab.—The area devoted to cotton in the Punjab (excluding Native States) in 1924 was estimated at 1,781,353 acres, or 37 per cent. more than in 1923. Of this total, 675,800 acres were planted with Punjab-American as compared with 383,851 acres in the previous year; this cotton now forms 40 per cent. of the total irrigated cotton crop, and is mostly of the 4 F variety. The newer variety, 285 F, was grown on 21,000 acres in 1923, and is rapidly extending, especially in the Lower Bari Doab Canal Colony. Efforts are being made to improve the native cotton for the non-irrigated tracts, and the Bhatla variety grown in Hansi was planted on 40,200 acres as compared with 22,000 acres in the previous year. The farmers who grew American cotton in 1923–24 instead of the native kind, increased their profits by Rs.42 per acre. Much difficulty is created by the mixing, which takes place in the ginneries, and which lowers the reputation of the cotton and causes a reduction in prices. It is hoped that this state of things will be remedied by a Bill for the Regulation of Gins and Presses, which was introduced into the Legislative Assembly in September 1924.

The Agricultural Department has distributed the *Mollisoni* type of selected native cotton in the canal colonies for cultivation on the areas not yet devoted to American varieties; this gives a larger yield per acre than the ordinary native cotton, and a lint of superior quality.

United Provinces.—Owing to the lack of an adequate supply of canal water, no extension has taken place in the cultivation of Cawnpore-American.

An improved type of Aligarh white-flowered cotton, known as Aligarh 19, has been planted on 2,500 acres under controlled cultivation, and it was anticipated that

30,000 acres would be devoted to this type in 1925. This bears a lint suitable for 12's.–13's. counts, and is superior in staple to that which it will replace.

The pink boll-worm is very prevalent in the United Provinces, and is probably the chief cause of loss of crop in average years. Methods of control are being investigated.

Central Provinces.—The distribution by the Agricultural Department of seed of the *roseum* type is being continued. A botanical survey of the cottons of the Province is being undertaken with a view to the improvement of the staple and the development of types resistant to wilt.

Burma.—Experiments are in progress with the object of isolating superior strains of Burmese cottons. The best strain of Shan cotton so far obtained has a staple of 0·88 in., and the best strain of Wagale a staple of 0·75 in. Both strains yield well and are being submitted to multiplication; large-scale trials are also being made for the purpose of spinning tests. A number of hybrids are being studied.

Bengal.—A survey of the Bengal cottons has been nearly completed, and an effort is now to be made to improve the hill cottons of the Chittagong and Garo Hill tracts. Encouraging results have been obtained in preliminary trials with varieties of the American type. Cotton growing is not likely to become of any importance in the plains of Eastern Bengal, but there are good possibilities on the uplands of Western Bengal.

Mysore.—In 1923–24 the area devoted to cotton in this State amounted to 84,000 acres, of which three-quarters was planted with the Sannahatti or Kumpta type, and the remainder principally with the Doddahatti or Dharwar-American kind. The former is grown on the black soils and the latter on the red soils. The isolation of improved types of both these cottons is receiving attention and sufficient pure seed of Sannahatti 69 has been obtained to sow about 2,000 acres. Improved types of Upland cotton have been produced which are of better staple than the ordinary Doddahatti and are practically free from red-leaf blight, which now causes much loss.

Hyderabad.—The work on the Gaorani or Bani type of *G. indicum* has been extended, and during 1923–24 seed was supplied for over 400,000 acres. The total area planted with this cotton was 1,397,000 acres, and the product is in great demand for Indian mills.

Baroda.—As mentioned on page 342, the Baroda Department of Agriculture is co-operating with the

Bombay Department. In 1923–24, a quantity of improved Surat 1027 A.L.F. seed, amounting to 160,000 lb., was issued, in addition to large quantities supplied from the Bombay Agricultural Department's seed depôts.

Cotton Industry of Indo-China.—An interesting paper on cotton-growing in Indo-China by J. Cardot, Chief of the Scientific Service to the Agence Économique de l'Indochine, has been published in *L'Agronomie Coloniale* (1924, **11**, 161 ; 1925, **12**, 15, 44).

The cottons of Indo-China are derived mainly from *Gossypium hirsutum*, L. and *G. indicum*, Lam., but occasionally *G. arboreum*, L. and *G. vitifolium*, Lam. are met with. In Tonkin, *G. indicum* is grown principally in the province of Nin-binh (360 hectares), Thai-binh (430 hectares) and Nam-dinh. In Annam, suitable conditions for cotton cultivation exist in Thanh-hoa in the north, and in the provinces of Binh-thuan, Khanh-hoa and Binh-dinh in the south. The area now devoted to the crop in Annam is estimated to be about 6,000–7,000 hectares, of which more than three-fourths (consisting of *G. indicum*) is situated in Thanh-hoa ; the cotton grown in the south is *G. hirsutum*. In Cochin-China, small areas are cultivated in the Baria province where all the four species named above are represented, but *G. vitifolium* predominates. In Cambodia and in the south of Laos, *G. hirsutum* is grown, whilst in the north of Laos, *G. indicum* is cultivated.

The industry is carried on almost exclusively by the natives ; a few French planters have made trials in Annam and Tonkin, but without much success.

In Annam and Tonkin the natives plant the cotton near their dwellings, where the soil is fertilised with village refuse and with cattle dung and human manure. As the cotton often succeeds a crop of rice, the first operation consists in ploughing up the stubble ; this is done at the end of November or the beginning of December. The land is then harrowed and rolled. The seeds are sown in January after having been soaked in water for a night and sometimes afterwards mixed with dry buffalo manure. Germination takes place from 8 to 15 days after sowing. During the month of April a second manuring is given, the manure being carefully applied around each plant. The total amount of manure used varies from 5,000 to 6,000 kilos. per hectare. In the same month, a few centimetres are cut off the tops of the young plants when 30–40 cm. high, in order to check their upward growth and promote lateral branching ; some of the natives, however, do not favour this practice of topping. Flowering generally begins towards the end of April, and the first bolls ripen about a month later. The picking, which is done daily by women, ends towards the middle of July. The whole bolls are gathered, instead of the cotton only being collected, and, as a consequence, the Indo-China cotton contains numerous fragments of broken capsules. By this method a woman can only collect about 10 kilos. of cotton per day. The fibre is withdrawn from the bolls at night and exposed to the sun during the following days; it is not stored until it is quite dry. Ginning, which is also done by the women, is effected by means of a primitive appliance consisting of two horizontal wooden cylinders which rotate in opposite directions; the fibre is drawn between the cylinders and collects on one side whilst the seed is detached and falls on the other side. It has been estimated that by means of this apparatus a woman must work for 11 hours a day for 7 days to gin 60 kilos. of seed-cotton, thus producing about 18 kilos. of lint. This mode of ginning is practised throughout Indo-China.

In the Baria province of Cochin-China, the Annamites cultivate cotton in conjunction with maize. The cultivation is restricted to red argillaceous soils which are particularly rich in phosphoric acid and sometimes in nitrogen. The land is prepared in a superficial manner and is not manured. The maize and cotton are sown together at the commencement of the rainy season (the end of May or the beginning of June). The maize develops in three months and matures in September. The stalks are not uprooted, but are cut off about 20 in. from the ground. The cotton plants continue to grow and begin to flower towards the end of the rainy season (end of October), and the cotton is picked in December.

In Cambodia, cotton is grown on the river-banks of the Mekong and its tributaries, which are periodically inundated. The area devoted to cotton varies between 12,000 and 20,000 hectares, and the total production between 3,000 and 8,000 tons of seed-cotton. Planting is done from the end of October to the beginning of December. The seeds, after being soaked for 24 hours, are sown in holes about 80 cm. apart in lines separated by about one metre; each hole is 10 cm. deep, and receives about ten seeds. The seeds germinate quickly, and after about a fortnight the seedlings are thinned out, leaving three or four in each hole. During the vegetative period several weedings are necessary. The first bolls ripen at the beginning of March. Picking is done by women and children every three or four days until the end of Ma. The whole bolls are gathered and, after being dried, are generally sold to the ginning factory at Ksach-kandal.

[Most of the further information in this article relating to cotton in Cambodia, including its cultivation on the non-inundated, red lands, has already been recorded by Flacourt (see this BULLETIN, 1919, **17**, 585)].

In lower Laos, cotton is grown on the banks of the Mekong, as in Cambodia, but the industry is not so well developed as in the latter country. The natives merely burn off the herbage and the brushwood, and sow the seed in most cases without any further preparation of the land and without manure. Planting is done in April or May, and the crop is generally over by November. The same operation is repeated in the following year on a new plot. Owing to the lack of means of transport, the production has hitherto been limited to the local demand, but in 1924 about 40 tons were exported to Saigon.

Cotton in Indo-China is very subject to attack by insect and fungoid pests which sometimes cause great damage to the crop. Comparatively little attention has yet been devoted to these pests. The presence has been observed in Cambodia and in Tonkin of a small lepidopterous insect which was supposed to be the pink boll-worm, but specimens which have been received at the Entomological Station in Paris have proved to be *Pyroderces simplex*, the larva of which is much less harmful than the pink boll-worm, and only attacks bolls which are already diseased. Other insects observed in Cambodia include a species of *Anthonomus* and *Dysdercus angulatus*, both of which attack the bolls, and a Pyralid moth, *Sylepta derogata*, the larvæ of which devour the leaves. Several fungoid diseases have been met with, caused by species of *Ramularia*, *Glomerella* and *Mycosphærella*.

Until quite recent times, the cotton industry of Indo-China was entirely in the hands of the natives, who not only produced the cotton, but also ginned it and spun and wove the fibre. In 1890, a Frenchman installed a ginnery at Ksach-kandal on the Mekong and subsequently erected an oil-mill. Prior to this it had been the custom for the greater part of the seed-cotton produced in Cambodia to be exported to Japan. The new enterprise led to increased prices being paid for the cotton, and thus stimulated production. Before long, however, the business passed into the hands of a Chinese firm, which still carries on the industry and continues to export a large proportion of the Cambodian cotton to Japan and Hong Kong.

Since 1903, the Administration has endeavoured to improve the ginning operations by introducing hand-gins of the Macarthy type. A little later the French Colonial Cotton Association sent twenty saw-gins to the Colony, but these efforts have had no practical result as the natives prefer to use the primitive apparatus already described.

There are two cotton mills in Tonkin, one at Haiphong and the other at Nam-dinh, which together employ more than 3,000 native workers of both sexes. They absorb nearly the whole production of Thanh-hoa (North Annam), as well as that of the provinces of Nam-dinh and Thai-binh, and, in addition, import large quantities of raw cotton from India and America. The annual imports of cotton into Indo-China amount to nearly 4,500 tons of ginned cotton, 2,700 tons of yarn, and more than 6,000 tons of cotton fabrics.

The average annual exports of cotton from Indo-China during the five years 1919–23 consisted of 2,017 tons of ginned cotton and 1,355 tons of seed-cotton. It is satisfactory that the exports of unginned cotton are gradually decreasing, as the ginned cotton can be sold to greater advantage and the seeds are utilised in the local oil-mill.

Although comparatively few attempts have been made by Europeans to establish cotton plantations in Indo-China, sufficient has been done to prove that the country can produce cotton capable of being spun into the same counts as American cottons.

The following administrative measures are suggested with a view to promoting native cotton cultivation in Indo-China : the organisation of co-operative societies or agricultural syndicates ; exemptions or reductions of taxes ; offers of prizes ; the free distribution of selected seed ; and the establishment of demonstration plots, ginning stations and regular markets in the chief centres of production. It is also suggested that research stations should be established in the principal producing areas where methods for controlling cotton pests could be studied and where the selection and improvement of the varieties under cultivation could be pursued in a systematic manner by competent experts.

Mineral Resources of Albania and Macedonia.—In the *Mining Magazine* (June, 1925, p. 329) D. A. Wray deals with the geology and mineral resources of Albania and Macedonia. The minerals mentioned as occurring in considerable quantities include asbestos, bauxite, magnesite, platinum, gold and silver. Other occurrences referred to are those of iron, copper, lead, zinc, manganese and chromium ores, coal, and indications of petroleum. Notes on some of these occurrences are given in the following paragraphs:

Chromium Ore.—Important chromite deposits occur at Eles Han on the Mitrovitsa-Skoplje Railway N.W. of Skoplje.

The productive localities are Radusha, Goranche, Orache, Svilari, Krvenik and Tikmesh. At Lipljan on the Uskub-Mitrovitsa Railway, 10 miles south of Prishtina is a chromium ore mine, and chromite has been reported at the villages of Dolova and Seres.

Ten miles north of Kumanovo is a small chromite mine at Preshevo, and chromite was formerly mined at Rabrovo, south of Strumitsa.

Coal.—Tertiary lignite deposits are worked east of Tirana and 20 miles east of Durazzo in Central Macedonia. Similar deposits are found at Tepelini, 30 miles east of Valona in Southern Albania. Lignite deposits occur around Lake Ochrida and near Koritsa in the localities of Mborja, Plyasa Kolibe and Drenovo. Others occur at Herseg (or Kolonia) and at Kuj, in East Albania.

Around the western and southern shores of Lake Ochrida, lignites occur at Golik in the Upper Skumbi Valley; at Krushova, Drdosha, and Nicha, S.W. of Pogradets; and at Cherava, 4 miles S.E. of Pogradets. There are other less important deposits around Pishkopeya in the Upper Drin Valley.

In Macedonia lignites have been mined at Svilari near Skoplje, and in the Ovce Polje near Veles; also at Belakovce, 15 miles E. of Kumanovo.

A large area of Oligocene lignite deposits occurs on the north of the Vardar Valley around Veles, Shlip and Krivolak in which several mines are working.

In Southern Macedonia, lignite has been worked at Meljnitsa and Vitolishta, 25 miles east of Monastir, and at Zhivonia, 18 miles S.E. of Monastir, the last being of some importance.

Copper Ore.—Copper ores occur at Rehova, Vithkuq, and Kamenitsa south of Koritsa in S.E. Albania, and copper ore also occurs in the Sutorman Mts. near Scutari.

Copper ores were formerly mined at Trepatsa near Dibra, close to the frontier between Jugoslavia and Albania.

Occurrences of copper ore have been reported at Ghevgeli, Mirzenci and Davidovo near the Jugoslavia-Greece frontier, but not in important quantity.

Iron Ore.—No very important iron ore deposits are known in this region.

Magnetite deposits of considerable extent are found at Mumulishta on the western shore of Lake Ochrida and at Martanesh in the Upper Mati Valley to the west of Dibra. Pisolitic iron ore deposits of considerable extent occur at Ovce Polje near Veles, and between the Vardar and Lupena valleys north of Skoplje.

North of Prilep in the Babinea district are iron ore deposits which have been worked in past years.

Magnetic iron ores are found in talcose schists S.W. of Kriva Palanka in the Osogov Mountains and also at Sredorek and Sracin in the same district. Siderite is found in some abundance at Dobrovo, south of Kratovo.

Manganese Ore.—Deposits of manganese ore are found around Goredzik, and to the north of Drama ; also between Eski Kavalla and Bademli Ciftlik, north of Kavalla. All these were mined during the war.

Other manganese ore deposits occur near Gradsko, twelve miles south of Veles.

Lead and Zinc Ores.—The old lead mines of Kratovo, exploited intermittently since the Middle Ages, were worked again by the Austrians during the Turkish occupation of the district. At Zletovo is a primitive lead-smelting plant. The most important lodes are at Dobrovo, 5 miles south of Kratovo, where a vein ranging in width from 6 to 12 ft. was worked.

Dugi Hrid near Kratovo is another ancient and well-known lead-mining centre.

South of Kriva Palanka in the Osogov Mountains, close to the Bulgarian frontier, are old lead mines ; and further south, near Petchevo in the Males Mountains, copper and lead ores have been mined at Bukovi.

In the extreme south of Macedonia, lead ores were formerly mined at Gurichet, near Ghevgeli in the Vardar Valley, and also north of Lake Doiran.

In Western Macedonia, lead has been mined at Opsinca, on the eastern shores of Lake Ochrida, and also at Janjevo, ten miles south of Prishtina.

There are old silver-lead mines near Telovo in the Shar Dagh Mountains, not far from the Albanian frontier.

Petroleum.—Indications of petroleum in Albania are found in the Selenitsa asphalt deposits, 7 miles N.E. of Valona. These deposits have been regularly exploited. Two instances of petroleum outbursts have been recorded from this district, and similar outbursts are known to have occurred near Durazzo. Petroleum exudations, accompanied by salt water and gas, occur at Bukowik, 7 miles S.W. of Lake Scutari. Other indications of petroleum have been observed in the higher parts of Albania in Neogene strata.

Beds of asphalt and bitumen are known at the following localities: immediately south of Elbasan; at Kamenitsa, Bella Voda and Golik in the neighbourhood of Koritsa in S.E. Albania; and at Kuchova not far from Berat.

South of Tirana and Elbasan there are gently folded Lower Tertiary beds showing numerous surface indications of petroleum.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS AND FODDERS

Beet Sugar.—*The Report of the Commission of Enquiry in the De Vecchis Beet Sugar Process* (1925), issued by the Ministry of Agriculture and Fisheries, deals with the new desiccation method of handling beets invented by Dr. De Vecchis. The process was considered to be of such promise and importance that a commission visited Rome and Loreo, and inspected the factory at which the commercial production of sugar by this process was in actual operation. Up to the present, sugar has been extracted from beets by the diffusion method, in which fresh beets, after being washed and sliced, are treated with warm water. By this process it is necessary to treat the roots within a strictly limited time, otherwise they ferment and decay; further, an abundant water supply is necessary, and the factory must be operated on a sufficiently large scale to justify overhead charges, and must be within economical distance of the beet-growing area. The advantages accruing from the desiccation of beets, whereby they are rendered proof against decay, capable of storage, and transportable at a lower cost, have long been recognised. The De Vecchis process consists in desiccating the sliced washed beets in a drying apparatus by means of a hot air blast, whereby the moisture in the beet is reduced from 80 per cent. to 3 per cent., and the albuminoid and pectic matter is coagulated. The slices leave the drier as rigid, horny cossettes, which can be stored for several months without undergoing fermentation. This enables the process of extraction to be extended over a long period and affords the farmer a free market. The sugar is extracted by lixiviation instead of diffusion ; less water is required, and the juice obtained contains less albuminoid and pectic matter and is clearer, higher in sugar, and denser than diffusion juice. The juice is purified by adding finely ground lime, followed by superphosphate, and one filtration only is needed. Less lime is used in this process, and there being less sludge, the difficulties attending its treatment and disposal are reduced. The juice after purification can go direct to the vacuum pans for boiling, and the whole equipment for evaporation in multiple-effect apparatus, which is necessary in the diffusion process, is not required for the De Vecchis process. The Report states that the process has scarcely emerged from the experimental stage, and that the plant as seen at Loreo needs improvement. It concludes with " while the principles of the De Vecchis system are in our opinion technically sound, the whole question of their technical application is still open. Until definite figures concerning the cost of the system, working on a satisfactory industrial basis, can be produced, it is extremely difficult to say whether the claims made for the system would be realised in practice."

Sweet Potatoes.—*Farmers' Bull.* No. 1442, *U.S. Dept. Agric.* (1925), entitled " Storage of Sweet Potatoes," describes the methods for successful storage whereby the necessity of selling the crop as soon as it is harvested is obviated, and the marketing may be extended over a large portion of the year. The first essential is that the potatoes shall be well matured before digging, and the second that they shall be carefully handled in digging, gathering, hauling and unloading so as to prevent bruising or breaking the skin. The third and fourth essentials are thorough drying or curing in the storage house and the subsequent maintenance of a uniform temperature by the adjustment of artificial heat and ventilation. Various types of houses are described in the bulletin and plan, and lists of materials required are included. Storage in banks and pits is also described, the main disadvantages of this method being the large proportion of loss due to decay, and the inferior quality of the sound potatoes due to lack of proper curing.

Bananas.—*Queensland Agric. Journ.* (1925, **23**, 282) contains a comprehensive article, entitled " Grading, Packing and Handling of Bananas." The information has been prepared to assist in raising the general quality of the Queensland fruit, which, it is stated, has suffered in reputation of late years owing to inferior handling by some of the growers. The methods described are those of the most successful Queensland growers. Rough handling is the chief source of trouble, and it should be realised that it is necessary to preserve the skin of the banana in a sound, unbroken condition. It is considered by southern dealers that bruising and other injuries may be avoided by sweating the fruit for from 40 to 50 hours prior to packing; firm packs are thus assured and less bulge is required in the cases. This procedure is recommended, and entails cutting the bunches into hands, as proper sweating cannot be done on the bunch. A slight bulge in packing is necessary to allow for subsequent shrinkage, but the fruit if not sweated will arrive slack and marked in spite of even a large initial bulge. The whole question of marketing is fully discussed and there are seventeen practical illustrations.

Coffee.—Attention was drawn to a serious outbreak of the insect pest, *Stephanoderes coffeæ*, Hagerdorn, in the plantations of Sao Paulo, Brazil, by the report of the commission appointed to investigate the menace (see this BULLETIN, 1925, **23**, 61). A review by Dr. O. W. Willcox of coffee conditions in Brazil as affected by a year's ravages of the pest appears in *Tea and Coffee Trade Journ.* (1925, **48**, 803), in which it is stated that the work of combating the bug has added a cost, probably permanent, of 5 cents a pound to all coffee sent to consumers, and that there is little reason to hope for a decline in coffee prices. The main strategy in the war against the Stephanodores is to deprive it of food during the off-season, and thus starve it out, and to do this effectively it is necessary to remove and destroy every coffee berry, whether on the tree or on the ground, that has been overlooked in the main harvest or has developed from late flowers. Before repicking, it is necessary to clean the trees, removing all dead leaves, abnormal growths, bird and spider nests, mosses and everything that might hide a coffee berry. The repickers then remove from the trees every berry, mature or immature. This work may be done by children and women, who are paid about 50 cents gold a day. They are followed by boys and men at 75 cents a day, who remove the trash from under the trees and pick up all fallen berries. They also search the trunk for old knot-holes into which infested berries might fall, and plaster up the holes with clay. All trash is either deeply buried or burned. Upon the thoroughness of these operations depends the degree of infestation in the next crop, any expense saved by skimping the repicking being more than compensated in damage done by the progeny of bugs that escape destruction. Although the campaign against the pest has been conducted satisfactorily in certain areas, it has not yet become general, and, in spite of the efforts of the Defence Service, in several badly infested fazendas not even gleaning or clean picking has been carried out. It has been shown by the Service that, by clean picking, the degree of infestation can be reduced from 96 per cent. at the commencement of the harvesting of the crop to only 5 per cent.

Tepary Beans.—In connection with the attempts to introduce the tepary bean (*Phaseolus acutifolius*) into Burma (see this BULLETIN, 1918, **16**, 286), it is interesting to note that a study of the digestibility of the beans appears in *Journ. Agric. Research* (1924, **29**, 205). The results obtained with these beans, employing men as subjects, are compared with the results of other legumes under similar conditions, and it is shown that tepary beans are well utilised by the body and are a valuable food.

Kikuyu Grass.—This grass (*Pennisetum clandestinum*), which is a native of the Belgian Congo, and now generally found in British African territories, is compared with paspalum as a fodder plant for Auckland Province in *New Zealand Journ. Agric.* (1925, **30**, 28). It does well under the soil and climatic conditions of a great part of the Auckland Province, particularly the Northern part. It produces a quantity of feed which is quite equal to that yielded by paspalum, and it has a longer growing period than the latter. Although most of the palatable feed is obtained between December and April, by top-dressing with a phosphatic manure a succulent winter growth can be produced. The best results with Kikuyu grass have been gained where it has been grown in association with a legume, white clover and *Lotus major* being the two most commonly sown. This pasture can be grazed, cut and fed green, or made into hay, which is relished by stock. Kikuyu grass was found to stand drought well, and in addition it successfully competed against young fern and manuka (*Leptospermum scoparium*), which come in on areas where reversion is taking place. Such reversion is stated to be common in North Auckland, and Kikuyu grass may prove to be an important factor in bringing what is now waste land into a state of productivity. Further experiments in connection with grazing and top-dressing, which will extend over several years, are being carried out at Puwera, in North Auckland.

ESSENTIAL OILS

Cultivation of Essential Oils in France.—With a view to stimulating the production of essential oils in France, in the district of Grasse, M. R. Cerighelli has compiled an instructive brochure entitled, *La Culture des Plantes à Parfum dans le Midi de la France* (*Notice No.* 18, *Office Nat. des Mat. Prem. veg., Min. du Comm. et de l'Indust., Paris,* 1925). This important industry is now suffering from the effects of competition and consequent low prices, which have not risen in proportion to those now obtaining for other agricultural products. As a result the cultivation of the geranium has almost ceased, and that of the rose is with difficulty holding its place. At present jasmine is one of the most remunerative crops, and a good deal of new land is being devoted to its culture. It is with this crop that the present brochure is especially concerned, and with the causes and treatment of a fungal disease to which it is exceedingly liable. The writer's researches have shown that jasmine requires a well-drained soil, and will then benefit by abundant irrigation. In some districts the plant has been damaged by the larva of a moth, *Glyphodes unionalis,* but if this pest increased it could probably be successfully combated by the introduction of a parasitic fly. Fields of jasmine have suffered much more seriously, however, through the ravages of a fungus which attacks the roots, and which has not yet been identified. As yet no means has been found for sterilising soils infected with this fungus, which is generally introduced by insufficiently decomposed organic matter. The land, therefore, should if possible be cleared by hand, and farm manure used with great caution. Plants appear more immune in a clay soil, possibly because sulphate of iron with which they are treated is more effective here than in a calcareous soil. The writer considers it probable that a good deal can be done towards combating the disease by wise selection, both of the stock and the slips for grafting. *Jasminum officinale* is as a rule more immune before being grafted with *J. grandiflorum.* Hybrids of *J. officinale* and the Spanish variety may prove stronger. Immunity would also be increased, probably, by selecting cuttings from healthy plants in infected areas. Slips from branches bearing double flowers should be avoided, for although the flowers are heavier and richer in oil, they frequently do not mature until the weather breaks, and sometimes turn brown and fall off prematurely. So much research work is required in connection with the culture of jasmine and other essential oil plants that the writer urges the establishment of an experimental research station in the neighbourhood of Grasse.

Oils and Oil Seeds

Babassu.—During the last ten years considerable interest has been taken in babassu nuts which are now being exported from South America in large quantities. A comprehensive account of the palm, its uses and exploitation, has recently been published as a monograph by the Ministry of Agriculture, Rio de Janeiro, entitled " O Babassu " by E. Teixeira da Fonseca. The palm, the botanical name of which, according to the author, is *Attalea speciosa*, Mart. (=*Orbignia Martiana*, Barb. Rodr.), is found in South America from the Amazon to Matto Grosso and Bolivia. The nuts, which constitute the most valuable part of the tree, are allowed to fall to the ground, and are then collected. Each palm yields annually from 2 to 8 bunches of fruits, each bunch containing from 200 to 600 fruits. The nuts contain from 2 to 6 kernels, which yield over 60 per cent. of a white fat. The shells, which are very hard and thick, are generally removed by hand, although in one or two places power-driven machines are used. In the first of the two native methods, the operator squats on the ground and has an axe under his thigh with the edge pointing upwards. With his left hand he places the nut along the edge of the axe and with his right gives it a smart blow with a mallet, whereby the nut is cleft open, leaving the kernels free and clean. Five kilos. of kernels per day may be obtained by this method. In the other method, the nuts are broken by placing them, several at a time, in the hollow of a large tree trunk and giving them a series of violent blows with a hammer. This method is inferior to the former as the kernels are very liable to be broken. The Brito Passos nut-cracking machine requires three men to work it, with five women to pick out the kernels, and will supply from 150 to 200 kilos. of kernels per 8-hour day. This machine extracts 80 per cent. of the kernels, provided the nuts are dry. A battery of eight of these machines is employed in one factory, being run by a 6 h.p. motor and yielding 1,500 kilos. of kernels in 8 hours. The necessary personnel is 56 men.

Besides its use as an edible oil, for soap-making, and as a lubricant, the oil is stated to be suitable for use as a fuel in motors of the Diesel or semi-Diesel type. The later sections of the monograph deal with the analyses of the oil and cake, and with the edibility of the oil. (See also this BULLETIN, 1917, **15**, 38).

Coconuts.—The area under coconuts in British Guiana in 1923 was 22,970 acres, a decrease of 3,630 acres compared with the corresponding figures for 1922 (*Rep. Dept. Sci. and Agric. Brit. Guiana*, 1923, p. 10). This decrease is largely due to the abandoning of certain plantations on account of the prevalence of bud-rot, neglected control and unsatisfactory conditions of drainage. The production in the year under review was nearly 16 million nuts, of which 2,650,000 nuts were exported as such. A large proportion of the production is used locally and for the preparation of copra, of which 8,401 cwts. were exported, whilst the export of coconut oil amounted to 26,621 gals.

Macadamia ternifolia.—The Macadamia or Queensland nut is a native of the coast district of Queensland and the north coast district of New South Wales, where it is known as the " Bush Nut " or " Possum Nut." Seeds of the tree were introduced into Hawaii about 1883, and the results have indicated that the nut is one of the most promising for commercial cultivation within the tropics and sub-tropics (*Journ. Oil and Fat Indust.*, 1925, **2**, 44). The tree begins to bear from 3 to 8 years after planting, and often produces nuts for more than half the year. The kernels, which represent about 29 per cent. of the nut, contain 76 per cent. of a colourless oil suitable for use as a salad oil. A specimen of the oil gave the following constants: specific gravity at 15·5° C., 0·9141; saponification number, 193·7; iodine value, 74·2 per cent.; acid value, 0·22. The residual press-cake, containing 8 per cent. of oil, had a protein content of 35·6 per cent. It is considered that when this tree becomes more generally known and is planted in sufficient quantities to be of commercial importance, it will prove a valuable source of oil and oil-cake as well as of dessert nuts.

Oil Palm.—The Report of a Committee appointed by the Secretary of State for the Colonies in September 1923 to consider the best means of securing improved and increased production of palm oil and palm kernels in West Africa has recently been published by the Colonial Office (*Colonial No.* 10, 1925). The merchants and others interested in the British West African Colonies, who suggested this enquiry, had in view the admittedly wasteful collection and non-collection of oil palm fruits in those Colonies, the laborious native methods of manufacturing palm oil and palm kernels, and the rapid progress being made on the oil palm plantations in Sumatra, Malaya and elsewhere. After reviewing the developments and progress made in the Dutch East Indies and the measures taken in French West Africa and the Belgian Congo to meet the threatened competition, the Committee were satisfied that unless important improvements are promptly introduced there is a grave danger of the palm products industry in British West Africa being seriously affected.

It is felt that besides a continuation of the chemical and botanical investigations now being carried out by the various Agricultural Departments in the British West African Colonies, there are more urgent matters requiring immediate action, such as the introduction of modern machinery and the offering of adequate inducements to attract private enterprise to erect mills. The following inducements the Committee considers desirable in order to give reasonable prospects of success : (*a*) the person undertaking to erect a pioneer mill should be given all possible assistance in acquiring a suitable site on freehold or long leasehold terms ; (*b*) he should be protected for a period of twenty-one years against any rivals erecting a mill within an area of 7 miles radius from the mill ; (*c*) he should, if he so desires, be able to acquire a plantation area of 5,000 acres at the most for cultivating oil palms, so as not to be entirely dependent on the natives for bringing sufficient fruit to the mill ; (*d*) he should be given facilities for making legally binding contracts with the natives for collecting fruit from specified areas ; (*e*) he should be given exclusive rights for the use of mechanical transport for collecting oil palm fruits within a certain area.

It is considered preferable that the oil palms should be cultivated by the native owners, who will sell the fruit to the mill owners, rather than that the mill owners should work the plantations.

Although in some of the British West African Colonies Palm Oil Ordinances are already in force, yet to give effect to the Committee's recommendations a certain amount of further legislation will be necessary.

The Hispid leaf miner (*Coelænomenodera Elæidis*, Maul.) has been found periodically attacking the oil palm in the Gold Coast (*Bull. Entomol. Res.*, 1925, **16**, 77). The pest was first recorded in this colony in 1909–10 as defoliating the palms in the Eastern Province to a large extent. It occurred again in 1919. On both occasions it was checked. by the rainy season which followed. The most recent attack lasted from July 1923 to January 1924. Specimens of the insect collected during the last occurrence were examined at the Imperial Bureau of Entomology, and pronounced to be a new species, *C. Elæidis*. Palms of all ages are liable to be attacked by the pest, except those less than 3 or 4 years old. The leaflets are attacked soon after unfurling, the larvæ mining under the epidermis. The affected areas of the leaves turn brown and blistered, and the leaflets are rapidly eaten away, and stripped bare to the midrib by the wind. This causes devitalisation and a falling off in the yield of bunches. Other food plants of the pest are coconut palms and Borassus palms, but these are only attacked when the pest is very abundant.

A period of from 82 to 94 days elapses between the laying of the eggs and the emergence of the adult, the eggs taking 28 days for incubation. The adults feed on the under-surface of the leaves. The numbers of the insects increase from time to time, but the cause of this periodic increase is not known. The rainfall and various hymenopterous parasites serve as natural checks to the spread of the pest. Artificial control is impossible under existing conditions, as the plantations affected are not under proper and efficient supervision. It is concluded that it is unlikely that the beetle will ever become a serious pest, owing to the high percentage of parasitism that takes place.

Further articles on the selection of oil palms in *L'Agronomie Coloniale* (1925, **12**, 89, 165) describe the method now being followed in Dahomey and the Ivory Coast in connection with the primary selection of suitable palms for reproduction (see this BULLETIN, 1925, **23**, 209). The scheme adopted is for the natives collecting the fruits to be accompanied by an observer who takes specimens of regimes from those palms which appear likely subjects and present an economic interest. These palms are numbered and their location noted so that further observations may be made at a later date. These collected regimes are then submitted to a physical examination as soon as possible, and the following data collected: the description of the regimes and the yield of fruits; the description, number and average weight of the fruits; the thickness of the pericarp and shell; the percentage of pericarp, shell and kernel; the description, average weight and dimensions of the nuts and kernels. From the results obtained, which may be supplemented by chemical examination, it should be possible to select palms which would be useful for further selection work.

FIBRES

Cotton

Egypt.—*Pink Boll-worm.*—It is well known that in Egypt the pink boll-worm passes from one cotton season to the next as a full-fed larva in the resting stage (cf. this BULLETIN, 1924, **22**, 194). Most of the resting larvæ are conveyed with the seed-cotton to the ginneries, where they are destroyed by compulsory heating at 57–60° C., but some of them remain in the bolls and seeds which fall to the ground and become buried during the winter under the succeeding crop (usually berseem or wheat). Willcocks, in a paper contributed to the Third Entomological Congress at Pusa on " Experiments in Egypt on the Survival of Resting Pink Boll-worms in Ripe Damaged Cotton Bolls buried at Different Depths," stated that he had found that it was only at depths of less than 15 cm. that there was any noticeable survival of worms through the winter.

Experiments have now been made by C. B. Williams, M.A., and Ibrahim Eff. Bishara, using double seeds (i.e. seeds spun together in pairs by the resting larvæ) instead of bolls, as in this way it was possible to estimate more accurately the number of worms present at the commencement of the experiment and so to determine the death-rate under different conditions. The results of this work have now been published as *Bulletin No.* 58 (1925), *Technical and Scientific Series, Ministry of Agriculture, Egypt.*

The seeds were buried at depths of 5, 10 and 15 cm. on five plots of land at Giza, which were treated as follows : (1) under grass watered once every two weeks ; (2) under berseem watered about once a month ; (3) under wheat watered about once every two months ; (4) under dry bare fallow to be followed by cotton ; and (5) without any crop and not watered. The results obtained fully confirm those recorded by Willcocks, and show that the death-rate of larvæ buried in winter is least near the surface and increases with depth until at 30 cm. there is no survival. They also prove that the moister the land is kept during the winter, the more rapid is the death-rate of the larvæ. The larvæ die very quickly in berseem but less rapidly in wheat, whilst in dry fallow a number survive until the next crop. Excessive artificial watering, such as watering every two weeks or a very heavy continuous watering for a short period at the beginning, is very destructive to the worms and under these conditions no moths reach the following crop.

Iraq.—In January–February 1925 Mr. W. H. Himbury, General Manager of the British Cotton Growing Association, visited Iraq in order to gain a knowledge of the general conditions under which cotton is grown in that country and the conditions of living, so as to enable him to form an opinion as to the prospects of the cotton industry. He also desired to inspect the Association's Staff quarters and the construction of the new ginnery, including the general lay-out of the plant, the storage accommodation for seed-cotton, bales, etc. On his return, Mr. Himbury presented a preliminary report to the Council of the Association which has been published, together with an illustrated account of the conditions in Iraq and a record of his personal observations, as pamphlet *No.* 88 (1925) *of the British Cotton Growing Association*, entitled " Iraq (or Mesopotamia) as a Source for Increasing Raw Cotton Supplies."

Mr. Himbury draws attention to the importance of the political factor not only to the extension of cotton-growing, but also to the general economic development of the country. Cotton-growing is still in its initial stages. During the years 1921–24 the production has been as follows: 1921, 60 bales; 1922, 300 bales; 1923, 1,100 bales; 1924, 2,500 bales. Practically the whole of this cotton has been bought, ginned and baled by the Association. The average yield of lint is about 150 lb. per acre. The cotton is sown between the end of the first week in March and the end of the first week in April, and the crop is picked from August to November.

In 1919 Messrs. B. Crapper and F. Hodgkinson visited Iraq on behalf of the Association and, as a result of their recommendations, a pioneer ginning factory was established at Shaikh Janaid. Owing to the increased production in 1924, a large up-to-date pneumatic ginnery has now been sent out which is capable of turning out 5,000–6,000 bales (each of 400 lb.) per annum.

Mr. Himbury considers that in Northern and Central Iraq there are possibilities for the production of cotton of excellent quality, but that the prospects in Southern Iraq are less satisfactory on account of the presence of considerable quantities of soluble salts in the soil. Irrigation and drainage schemes are discussed, and it is shown that such schemes must be carried out before any rapid progress can be made. The cotton crop in Iraq has not hitherto been greatly affected by insect pests, but it is sometimes attacked by the spotted boll-worm and by jassids. A difficult problem is created by the scarcity of population; the total area in the British Mandatory Sphere is about 150,000 square miles, whilst the population is less than three millions, and consists largely of nomadic Arabs. Although large numbers have recently settled on the land, it is unlikely that any rapid increase will take place. The suggestion that labour should be imported from India and Egypt is not regarded as feasible, and it is considered that better results would be secured by the gradual natural increase in the population under existing conditions.

In conclusion, Mr. Himbury states that the following are the main requirements in the development of Iraq: (1) the establishment and maintenance of a strong Government with a sound financial policy; (2) the inauguration of a definitely settled policy of drainage and irrigation; and (3) a steady increase in the agricultural population, which would doubtless follow the accomplishment of the first two factors.

Queensland.—An interesting account of the development and present position of cotton-growing in Queensland has been contributed to the *Empire Cotton Growing Review* (1925, **2**, 169), by G. Evans, C.I.E., M.A., the Empire Cotton Growing Corporation's Director of Cotton Culture in that State. The following notes deal with certain points discussed in the article.

Reference is made to the urgent need for an improvement in the seed supply. The Durango cotton, which has been introduced from the United States, has been distributed to selected farmers who have grown it, under supervision of the Agricultural Department, in sufficient quantity to provide for the total requirements of next season. The supply and distribution of this cotton seed is controlled by the Department, and the pure seed has been restricted to groups of farmers in certain particular localities. These groups undertake to grow this one variety exclusively and to plant it only on clean land. This scheme for replacing the old mixed seed with a pure variety is thus nearing completion, but the final elimination of the former is being delayed by the practice of ratooning. It is pointed out, however, that in order to obtain satisfactory types of cotton, suited to the varied conditions of all the different sections of the cotton area, plant-breeding work will be required.

With this object in view, a Central Research Station has just been established at Callide in typical country between Rockhampton and Gladstone. A subsidiary station is located at Monal in the Upper Burnett country, and experimental work is also being carried out for the south-eastern area at Gatton Agricultural College. At present, endeavours are being made to evolve improved types of Durango, and similar breeding work is being done with Acala, Lonestar and Webber 49; other types also are being tested on a small scale.

Emphasis is laid on the fact that in order to develop *a permanent and profitable* cotton-growing *industry, it is* necessary that clean and careful methods of cultivation should be employed, and that cotton of a high quality and good length of staple (1⅛–1¼ in.) should be produced.

Mr. Evans is of opinion that the practice of ratooning is unsound, as the second-year cotton "is decidedly inferior as a whole to the annual, being not only shorter in the staple, but singularly deficient in 'drag,' due presumably to lack of twist in the fibre." Although in dry seasons a ratooned crop may do well, it is less satisfactory under normal weather conditions, such as those of the present season; the ratooned cotton plants in districts remote from the coast have mostly died out during the winter. Another objection to ratooning is that, in the early spring, the plant puts out a larger number of suckers from the crown than the root can properly support, and consequently the plants wilt badly in the first hot spell and shed most of their young bolls and squares. If the plant withstands the drought, it tends to produce large numbers of small bolls bearing cotton which is deficient in staple. A further disadvantage is the habit of the ratooned plant to spread over the ground, rendering the cotton more expensive to pick and causing many of the bolls to be damaged by rain; this habit, moreover, makes it difficult to till the fields and keep them clean. The chief danger from ratooning, however, is considered to be connected with the occurrence of insect pests. Although the majority of the farmers cut their plants to within 6 or 8 in. of the ground, some turn the cows into the field or simply leave the crop to stand over, whilst others sow Rhodes grass among the standing crop and leave the land as a grazing paddock. Under such conditions, the fields form a good harbourage for pink boll-worm and other pests which are thus enabled to carry over from one season to the next.

The menace of the pink boll-worm is now becoming understood by the farmers and every effort is being made by the Government to prevent its spread. Simon's heaters have been installed at the ginneries to ensure that all the seed sown has been efficiently treated. The control of the pest where it is already established is in the hands of the farmers themselves. It is probable that drastic action against the boll-worm will eventually become necessary.

Flax

United Kingdom.—Reference to flax cultivation in the United Kingdom was made in this BULLETIN (1919, **17**, 422), attention being drawn to the work of the British Flax and Hemp Growers' Society and its subsequent transfer to the Flax Production Branch of the Board of Agriculture.

In October 1924 the Board of Trade appointed a Committee to consider and report on steps which could be taken to bring about the growing of flax seed and flax in the United Kingdom on a commercial scale, and the Committee has recently issued an *Interim Report on Flax Seed* (H.M. Stationery Office, 1925).

After reviewing the earlier efforts, including those made during the war, to increase flax production in this country, the Committee express the opinion that the growth of flax seed and flax on a commercial scale depends on the development of new strains of pedigree seed. In this connection, reference is made to a strain, known as J.W.S., which has given so much promise that arrangements have been made between the Linen Industry Research Association, the Imperial Government and the Government of Northern Ireland for the factories at Bunford and Lopen in the Yeovil district to be taken over by the Association for the purpose of bulking the seed. The Committee recommend that these factories should be placed in the hands of a body formed for the purpose and that another factory should be acquired shortly to deal with an increased area. The seed, after being placed on the market, would be multiplied further by private enterprise, but the Committee consider it essential that the factories should be retained permanently as a source of mother seed, thus ensuring a continuous supply of pedigree seed for distribution.

In the *Journal of the Ministry of Agriculture* (1925, **32**, 310) it is stated that the Government have adopted the recommendations of the Committee and have arranged for the acquisition of the two factories and for the constitution of a Society, not trading for profit. This Society, the Flax Industry Development Society, has now been formed, its primary object being the supply of seed of superior quality, thus providing the basis for the development of the existing industry. It is hoped that this scheme will lead to the establishment in England of a seed-growing business supplying flax seed of a quality never hitherto put on the market, and to a great extension of the area of flax grown for fibre in all parts of the British Isles and in other parts of the Empire.

Paper-making Materials

Sorghum from Madagascar.—Fragments of stalks received from Madagascar under the name of "Bakaka," a form of *Sorghum vulgare*, Pers., have been examined as a paper-making material by F. Heim de Balsac, in collaboration with J. Maheu and M. Cercelet, and the results are recorded in *Bull. de l'Agence Gén. des Col.* (1925, **18**, 360).

The stalks contained 9·59 per cent. of moisture; on chemical examination they yielded 6·22 per cent. of ash, 82·83 per cent. of cellulose, and 10·05 per cent. of lignone. On digestion with caustic soda of 5 per cent. strength for seven hours under pressure, a yellowish-brown pulp was obtained which bleached with great facility. The yield of bleached pulp amounted to 37 per cent. On microscopical examination, the pulp was found to be composed of fibres, fragments of vessels and a rather large proportion of cellular matter. The fibres were of two kinds: (1) fine fibres, which were remarkably regular, sharply pointed and had a very narrow lumen (sometimes absent), and (2) coarse fibres, which were fairly abundant and had a variable lumen. The finer fibres were 3–6 mm. long and 10–15 μ wide, whilst the coarser fibres had an average length of 5 mm. and a diameter of 30–35 μ. The felting power (diameter : length) was 0·005. Paper made from the bleached pulp was dull white, soft to the touch, and had a fair rattle; in general it was of good quality but a little lacking in suppleness.

Lianes from Indo-China.—In connection with investigations carried out by the Service d'Études des Productions Coloniales, on the suitability of certain woods of Indo-China for paper-making (this BULLETIN, 1923, **21**, 396) it has been found that in order to ensure satisfactory re-afforestation it is desirable, when cutting the trees, that the numerous lianes should be removed by which they are encumbered. As some of these lianes have already been employed by the natives for paper-making, it was considered worth while to investigate their possibilities in this direction. Specimens have, therefore, been examined by F. Heim and M. Cercelet, and the results are recorded in *Bulletin de l'Agence Générale des Colonies* (1924, **17**, 1609).

The lianes have not been botanically identified and are, therefore, referred to in the report under their native names, viz. Chac Buôm-Buôm, Chac Bim-Bim, Chac Cau, Chac Heo, Chac Dom, Chac Coec, Chac Dô, Chac Cuiong, Chac Coe, Chac Gan, Chac Dông Toi, Chac Khu-Ro, Chac Choai, Chac Chiu, Chac Pho, and Chac Giay.

All these lianes can be converted into pulp by similar treatment. In each case the samples were cut into pieces 3–4 cm. long and 3–5 mm. thick, and were digested with a solution of caustic soda of 3–4 per cent. strength under a pressure of 6 kilos. The digestion was usually carried on for 3 hours, in some cases for only 2½ hours, and rarely for 3½ hours. Bleaching was generally effected with average facility. The yields of pulp ranged from 20 per cent. to 32 per cent., except in the case of Chac Heo, which furnished 37 per cent. The average yield from the whole series was 28 per cent. The paper made from the pulp was generally of fairly good quality. Some difficulty might be experienced in separating the different species of lianes, but there appears to be no doubt that good results would be obtained by treating them in admixture.

Woods from French West Africa.—In this BULLETIN (1924, **22**, 230, 500) reference has been made to investigations of certain West African woods as paper-making materials which were carried out by Prof. F. Heim, in collaboration with M. Cercelet, J. Maheu, G. S. Dagand, and R. Heim de Balsac. In *Bull. de l'Agence Gén. des Colonies* (1924, **17**, 1377) a further report has been published by these workers on the wood of the "Émien" tree (*Alstonia congensis*, Engl.), a sample of which was received from the Ivory Coast. This tree is also met with abundantly in other parts of West Africa.

The wood contained 8·25 per cent. of moisture. On chemical analysis it yielded 0·91 per cent of ash, 0·63 per cent. of fats and waxes, 64·3 per cent. of cellulose, and 34·16 per cent. of lignone (expressed in each case on the dry material).

On digestion with caustic soda solution of 5·5 per cent. strength for 8 hours under a pressure of 3 kilos., a brownish-yellow pulp was obtained which bleached white with average facility. The yield of bleached pulp was 33 per cent. (expressed on the dry material). On microscopical examination the pulp was found to consist almost entirely of cylindrical fibres with narrow ends. These fibres have very thin walls and a very wide lumen; they vary in length from 1·0 to 1·5 mm. (with an average of 1·2 mm.) and in diameter from 25 μ to 35 μ (with an average of 30 μ), and have a felting power (diameter : length) of 0·025. The pulp gives paper of similar quality to ordinary wood-pulp papers.

MINERALS

Arsenic

Australia.—Two recently discovered occurrences of arsenic ore are described in the *South Australia Mining Review*, No. 40, 1924. One of these occurrences is in the Hundred of Waitpinga, near Cape Jervis, where the rock formation consists of a thin-bedded micaceous quartzite traversed by quartz veins. Of two veins that have been noted as arsenical, one has been prospected by a cutting and some shallow openings, none of which exceeds 12 ft. in depth. The ore-bearing portion of the vein ranges up to 9 in. in width, averaging about 3 in. The prospected lode has been traced 150 ft. inland, but there is no definite evidence of its persistence in that direction. Four samples of the ore gave, on analysis, an approximate average of 33 per cent. of arsenic and 8 dwts. of gold per ton, but contained no lead, silver, zinc or copper. The gross value of the ore sampled at the date of inspection was about £10 4*s*. per ton, out of which mining costs and freight would have to be deducted.

Another deposit of arsenical ore has been opened up to a depth of 15 ft., near Callington, where there appear to be several veins of ore in a formation of decomposed schist. Ten tons of ore have been despatched for treatment from this locality. A sample of stacked ore assayed 29·9 per cent. of arsenic, but contained only a trace of gold and no copper, lead or silver. This sample was a mixture of quartz, arsenopyrite and scorodite.

Coal

Canada.—A preliminary investigation of the coal deposits on Smoky, Hay and Berland rivers, Alberta, has been made by John MacVicar (*Canada, Geol. Survey Summ. Rept.*, 1923, Part B, p. 21). Sufficient data were obtained to show that there is a considerable amount of coal in this field awaiting development. The coal is of Kootenay age (Cretaceous) ; it varies from bituminous to semi-anthracite, and is suitable for steam, metallurgical and domestic purposes.

The following table is a summary of the approximate possible tonnage that may be obtained from this field :

Southern division, bituminous	425,820,000
Middle division, bituminous	2,174,400,000
Northern division, semi-anthracite and semi-bituminous	58,500,000
Northern division, bituminous	7,000,000,000
Eastern division, no estimate	
	9,658,720,000

The area covered by the report stretches N.W. from Brûlé Lake for about 80 miles, and varies in width from a few miles at the south to possibly 25 miles in the north. The southern part of the area is easily reached from the Canadian National Railway ; the northern part is reached by pack trail.

The Kootenay coal measures consist of a series of interbanded beds of coal, conglomerate, slate, shale and sandstone, over 3,000 ft. thick.

Considerable development has been done at the Brûlé Lake mine, in the Southern division. In a section of 3,681 ft. of coal measures there are seven workable seams, five of 7 ft., one of 12 ft. and one of 14 ft. in thickness. The mine is connected by a railway spur with the main line of the Canadian National and about 200 tons of coal a day are shipped for use by the railway. This group of seams may underlie an area of about 8 square miles, and if they maintain the thickness stated would contain between 400,000,000 and 500,000,000 tons of coal. On Scovil Creek one seam 12 ft. and another one 8 ft. thick are exposed.

In the Middle division, on the north branch of Hay River, about a mile below the mouth of Seep Creek, two seams of good clean coal, 8 ft. and 40 ft. thick respectively, are exposed. At Discovery Post there is a seam 8 ft. thick, and a little higher up the river, on the opposite bank, is a seam 40 ft. thick and two seams 2 ft. thick. About 3 miles farther up there is an exposure of 15 ft. of coal, and a mile above this, opposite the mouth of Carson Creek, three seams of clean coal, 2 ft., 18 ft. and 24 ft., were found. Two miles up Hay River, on Thoreau Creek, a 37-ft. seam is found, and between the north branch of Hay River and Little Berland River there is a seam over 100 ft. in thickness.

Various workable seams are found in the Northern division, the most important of which from an economic point of view is a 7-foot semi-anthracite coal bed covering an area estimated at 6 square miles, which gives approximately 58,500,000 tons of available coal.

The coal measures of the Eastern division have not been prospected so far as is known, but a number of coal seams are exposed, usually thin, but up to 5 ft. in thickness.

The railways will probably be the principal consumers of Alberta coal for some years to come. The uncrushed hard coal of this field should find a market as far east as Winnipeg. Part of the coal will find a market in the metallurgical industry of British Columbia to the west.

James McEvoy has reported on the National Coal Reserve on Smoky and Sheep rivers in the Northern division of Alberta (*Dominion Fuel Board*, No. 7, *Geol. Survey*, No. 2055). There are seven known seams of workable quality and thickness in the Reserve varying from 4 to 18 ft. in thickness, the total thickness of coal amounting to 62 ft. 7 in. In addition there are two seams of doubtful commercial value, one about 3½ ft. and the other 7 ft. thick, making a grand total of 73 ft. of coal. On the basis of 73 ft. thickness, the tonnage in the Reserve would be 3,424,363,000 tons, but, taking 25 ft. as actually extractable, these figures are reduced to 1,172,727,000. The tonnage of easily mined coal is one-fifth of the above or 234,000,000. The amount of extractable coal in the seven leases, having a combined length of 12 miles, included in the Reserve, would be 120,000,000 tons.

The Reserve is a valuable asset, but there is no need for its development for many years to come.

The Bow River Coal Basin within the Rocky Mountains, Alberta, is described by D. B. Dowling (*Canada, Geol. Survey Summ. Rept.*, 1923, Part B, p. 63).

The coal areas on the main line of the Canadian Pacific Railway containing, or likely to contain, the better grades of domestic coal are dealt with. Most of the coal already mined is very small and friable. The investigation carried out during July 1923 was directed towards an examination of the seams in what appeared to be a less-disturbed area south of Canmore. The coal near the surface appeared satisfactory, but it has yet to be proved what the seams will yield at a distance from the outcrop when beds under pressure from the present load of overlying strata are encountered.

There is a probability that the mining operations of Canmore No. 2 mine may eventually lead to some of the seams exposed in the hills opposite The Gap station. Further prospecting may lead to the discovery of many seams, some of which may have been seen previously in the vicinity of Canmore. Canmore No. 1 mine has been abandoned. Three seams have been worked in the No. 2 mine, viz. Cary (lowest), Sedlock (5 ft. 6 in.) and Stewart (7½ ft. to 8 ft.).

In Smith Creek, south of Canmore, several seams have been exposed. Seam No. 3 is 11 ft. 9 in. thick, having top and bottom benches 2 ft. 4 in. and 4 ft. thick respectively. The calorific values of samples of the upper and lower bench coals (dry) were 12,530 and 13,470 B.T.U. Seam No. 4 is about 8 ft. thick, and also in two benches, 2 ft. 3 in. (top) and 5 ft. 8 in. (bottom) thick. The calorific value (dry) is 13,765 B.T.U. Seam No. 5 is about 5 ft. thick, and the calorific value (dry) is 13,130 B.T.U.

In Marsh Gully the seams were not sampled. Samples previously taken showed seams from 7 to 14 ft. thick, with calorific values (dry) varying from 5,980 to 13,680 B.T.U. In Cairnes Gully, the Cairnes seam was 7 ft. 2 in. thick, the calorific value (dry) of the upper and lower halves being 13,950 and 13,660 B.T.U. respectively. In Wind Mountain Creek, a lower seam, 3 ft. thick, gave calorific values (dry) of 13,780 and 11,780 B.T.U., these being the lower and upper part of the seam respectively. An upper seam, about 6 ft. thick, consists of an upper bench coal, 3 ft. 9½ in. (calorific values—dry—11,960 and 12,660 B.T.U.) and a lower bench coal 1 ft. 11 in. (13,325 B.T.U.).

According to James McEvoy ("Smoky River Coal Field," *Dominion Fuel Board*, No. 7, *Geol. Survey*, No. 2055), at Anthracite station, east of Banff, in Bow River Valley, the coal is of the anthracite variety. At the Old Anthracite mine, fixed carbon, volatile matter and ash amounted to 88·72, 7·65 and 3·63 per cent. respectively, and at Panther Creek to 83·55, 10·58 and 4·94 per cent. respectively. These coals (including those of Cairnes Gully and Wind Mountain Creek described above) are non-coking, very good steam coals, excellent for furnace and stove use. Excepting their higher percentage of ash, they are similar to the Welsh coals that are now filling a considerable part of the market in Canada.

Madagascar.—In 1911 a thin seam of coal was discovered near Ampoza, near the left bank of the Ranobé River, seventy miles south of Cape St. Andrew on the west coast of Madagascar. Explorations, undertaken in 1923, have exposed, at a place called Masikampy, a seam about 2½ ft. thick, as well as two very thin beds. The outcrops of all these can be followed for about 650 ft. Near by are three or four seams, one of which is a little over 1 ft. thick. An analysis of a sample from the 2½ ft. seam gave the following percentages: water at

100–111° C., 2·55; ash, 30·2; volatile matter, 16·6; fixed carbon, 50·65. Calorific power, 10,976 B.T.U. A bore put down to a depth of about 380 ft. has disclosed 5 seams of coal, of thicknesses 18 in., 9 in., 9 in., 4 in., and 5 in., respectively (*Echo des Mines et de la Métallurgie*, Feb. 20, 1925, p. 92).

According to J. Duclos (*Bulletin Économique*, 1 and 2 trimestres, 1924, p. 47), the most interesting outcrops of coal in Madagascar occur at Benenitra, in the south-west. A somewhat schistose bed of coal occurs here as much as 8 ft. thick. The calorific power varies from 9,900 to 11,880 B.T.U.

Various thin seams of coal have been found in N.W. Madagascar, between Cape St. Sebastian and Point Blair.

The coal of Madagascar is of Permian age. The geological map, published in the *Bulletin Économique*, shows a narrow strip of Permian, ranging practically from north to south of the island. These are the oldest sedimentary rocks of Madagascar. The beds dip regularly westwards, or towards the sea, and the outcrops butt against the crystalline rocks (Archæan) which form the high plateau and eastern coast of the island (Permo-Triassic depression).

Lignite is also found in Madagascar. One very regular bed near Ampasiry is from 1½ to 2 ft. thick, and can be traced for long distances. The quality is excellent. Another seam of good lignite near Tulear is of Calovien (Jurassic) age. Some patches of lignite have also been found in the Upper Lias.

Copper

Canada.—Copper-bearing minerals were discovered in Petite Nation Seigniory, Papineau County, Quebec, in October 1923. The occurrence has been described by M. E. Wilson (*Canada, Geol. Survey Summ. Rept.*, 1923, Part C1, p. 74). Chalcocite occurs in grains and aggregates of grains up to ½ in. in diameter disseminated through pyroxenic gneiss, but most abundantly in the quartzose and pegmatitic phases of that rock. Bornite is found in irregular grains here and there in the chalcocite. From 25 to 30 ft. of ground, opened up at the surface, shows chalcocite and bornite more or less disseminated throughout, but the average percentage of copper present in the whole mass is probably less than 1 per cent.

Australia.—The development of the Wild Dog leases of Yelta, South Australia, continues to be satisfactory.

The leases practically adjoin the famous Moonta copper mines which were closed down in October 1923.

According to L. J. Winton, Chief Inspector of Mines for South Australia, the Wild Dog lode occurs as a pegmatite dyke in hard felspar-porphyry (*South Australia, Dept. Mines, Mining Review*, 1924, No. 39, p. 68).

John L. Pearson, Inspector of Mines, states that the present workings are 214 ft. in vertical depth (*Mining Review*, 1924, No. 40). Two shoots of high-grade ore had been found, the first of which did not extend below the No. 1 level, but the second or main shoot had been proved to a short distance below the No. 3 level, the stoping length in that level being 168 ft., an increase on the length as developed in the levels above. Moreover, a very rich foot-wall branch had also been found at this level. Various Government bores had previously been put down, and one of these had cut the lode beneath the main rich shoot at a vertical depth of 323 ft. 6 in.—the width being 18 in. and the assay value 8 per cent. of copper. On the No. 3 level the ore is mainly bornite and chalcopyrite.

Up to December 31, 1923, 3,077 tons of ore were produced, averaging 19 per cent. of copper. For the half-year ending June 30, 1924, the output amounted to 1,231 tons of ore, estimated at 14·7 per cent. of copper. By hand-dressing this yielded 563½ tons of shipping ore, assaying 28·5 per cent. of copper, which was exported, the Wallaroo smelter being closed down. The stocks of ore at the surface in August 1924 amounted to 70 tons containing 20 per cent. of copper, and 2,000 tons with 3½ per cent. of copper.

An exploratory crosscut is being driven from the end of No. 3 level north in order to test the ore-body discovered in one of the Government bores, which at a vertical depth of 228 ft. located 8 ft. of ore assaying 11·25 per cent. of copper and 1 dwt. of gold per ton.

A new pumping-engine was being erected in 1924 in order to develop the mine at a lower level.

Gold

Canada.—The ore deposits of the Argonaut gold mine, and some recent gold discoveries in the Larder Lake area, Timiskaming District, Ontario, are described by H. C. Cooke (*Canada, Geol. Survey Summ. Rept.*, 1923, Part C1, pp. 42 and 61).

The rocks in the immediate vicinity of the Argonaut mine consist of Keewatin lavas (pre-Cambrian) and two intrusives of later age. The older one of these is quartz-diorite and the younger one syenite-porphyry. Wide dykes of both intrusives occur in the mine. The ore-bodies are of two main types. One is a vein of auriferous chalcopyrite, quartz and calcite striking about N.E., dipping N.W. 60° and pitching N.E. 65°. The vein is a long, narrow lens, with a maximum width of about 1 ft. and up to 300 ft. in length. The fissures of this type are filled with vein materials that vary a great deal in composition from place to place. The gold contents accompany the chalcopyrite, which, when pure, is said to be worth as much as $200 a ton. These deposits have been worked to a depth of 500 ft. At this level the vein consists of magnetite, with minor amounts of chalcopyrite. In 1920 the old mill produced 4,607 tons of ore, with a gold content worth $7·01 per ton.

The second type of ore-body is a vein which strikes N. 10°–15° E., is vertical, and has a maximum width of 5 ft. It consists almost wholly of a dark grey, fine-grained calcite that in places forms a matrix enclosing fragments of an earlier, light brown, barren vein of oligoclase now largely replaced by calcite. The later vein of dark calcite contains albite and graphite together with a gold content worth from $40 to $60 a ton.

The recently developed gold deposit at Larder Lake, Ontario, lies about half a mile east of Pancake Lake, in the southern part of McVittie township. A large body of ore is now being developed here by the Associated Goldfields and Crown Reserve Mining Co. to depths of 500 ft. and 525 ft. respectively. The rocks are thin-bedded tuffs and lavas of Keewatin age (pre-Cambrian). The ore-bodies are lenticular replacement masses. The maximum width of the main ore-body is 40 ft., and the proved length is over 900 ft. The strike is N. 55° E. and dip S. 60°. Smaller lenses have also been discovered. The ore is mainly calcite with a good deal of quartz, heavily mineralised with pyrite and arsenopyrite.

The gold contents of the ore-body are between $2 and $20 a ton in value.

Recent developments in the goldfields of North-Western Quebec have been summarised in this BULLETIN (1925, **23**, p. 231). The geology of the deposits is described by H. C. Cooke (*Canada, Geol. Survey Summ. Rept.*, 1923, Part C1, p. 76).

The claims owned by the Noranda Mines, Ltd., including the Horne group, lie between lakes Heré and Osisko, Rouyn township. The principal rocks are ancient

Keewatin (pre-Cambrian) lavas cut by dykes of dolerite, felspar-porphyry, granite, etc.

The Powell vein, the original discovery of the district, strikes N. 30° W., dips E. 60°–65°, is from 3 to 6 ft. wide and has been traced for 3,600 ft. The vein materials are white quartz and some pyrite. Where the vein lies in granite for a total length of about 600 ft., the width varies from 2 to 12 ft., the wider parts being found in the somewhat numerous bends, so that the vein is a series of lenses connected by narrow parts. Gold accompanies the pyrite, being more abundant where the pyrite is fine-grained.

In the Chadbourne claim on the south the rocks are acid lavas, rhyolites or dacites cut by a few dykes of red felspar-porphyry. The lavas form a drag fold which is crossed by zones of shattering in which quartz, calcite and pyrite have been deposited, forming a network of veinlets enclosing blocks of the country rock. Both veins and country rock are heavily mineralised with pyrite. As in the Powell vein, the gold content accompanies the pyrite; the finer the grain the richer it is in gold.

In the Horne claims the rocks are dacites and rhyolites intruded by very fine-grained altered gabbro. The ore-bodies are replacement deposits in the rhyolite and rhyolite tuff. The ore minerals are pyrite, pyrrhotite and chalcopyrite in a gangue of rhyolite. The sulphides occur as scattered grains and also as solid masses. At least six sulphide bodies have been found; the gold contents vary a great deal, but in most cases are rather low. One sulphide body, more than 50 ft. wide at surface, consisting largely of massive pyrrhotite, averages $7 value in gold per ton and carries 7 per cent. of copper.

On the Stabell claims, Dubuisson township, the rocks are mainly Keewatin lavas cut by a few dykes of granodiorite porphyry. The Stabell vein strikes N. 60° W., and dips steeply N., and is of the fault-fissure type. The vein consists of quartz with sulphides and a little calcite, forming a succession of lenses of varying length and width (1 to 3 ft.). Near the dyke they are connected to form a continuous vein, but 800 ft. from the dyke they form isolated masses. The sulphides are chiefly auriferous chalcopyrite and pyrrhotite filling cracks in quartz. The gold contents are mainly in the chalcopyrite, which, when pure, is said to assay in value $200 to $300 per ton. Veins of three main types have been found, to date, in the Dubuisson township: (1) quartz-pyrite veins; (2) quartz-tourmaline-free gold veins; (3) a quartz-chalcopyrite-pyrrhotite vein.

In the Lake Fortune Mining Company's claims, Boischatel township, the rocks are Keewatin basalts, cut by dykes of syenite-porphyry. The ore-deposit is a strongly sheared zone, striking a little N. of E., and averaging 6–12 ft. in width, except at the eastern end, where it is from 200 to 300 ft. wide. Between Renaud and Fortune lakes the zone contains much quartz, carbonate and sulphides, generally near the dykes of syenite-porphyry. The vein filling consists of quartz, ankerite with some calcite, fuchsite, pyrite, chalcopyrite, tellurides (probably petzite and sylvanite), and free gold, the gold being obtained from these.

The properties of the Arntfield Gold Syndicate in the Boischatel township and some promising gold-bearing veins recently discovered in the township of Bourlamaque have already been described in this BULLETIN (1925, **23**, pp. 92–93).

Australia.—The Thunder Queen Gold Mine, Wadnaminga, South Australia, which was discovered about 1914, and worked for several years in a small way, is reported on by L. J. Winton, Chief Inspector of Mines for South Australia (*South Australia, Dept. Mines, Mining Review*, 1924, No. 40, p. 39).

The lode, which is in slate "country," strikes E.–W. and dips S. 30°–36°. The filling consists of quartz and ironstone containing more or less galena, together with some secondary oxide and carbonate of lead, and the lode has been proved to a vertical depth of about 100 ft. The average value of 34 samples taken from the lode, varying in width from 4 in. to 40 in., is 17·09 dwts. of gold per ton. Only one negative result was obtained. Payable samples were obtained over a length of lode of 300 ft., and ore containing up to 30 dwts. of gold per ton was found in the lode in the bottom workings.

The property appears to deserve a further trial, and in order to continue to develop and further test the ground, it is recommended that Nos. 3 and 5 shafts be sunk to a depth of about 125 ft., and a level be driven between them and eastward towards No. 2 shaft.

United States.—The geology of the region around Lead, South Dakota, and its bearing on the Homestake ore-body, is described by Sidney Paige (*Bull. 765, U.S. Geol. Survey*, 1924), further details being given of the geology of the Homestake mine than those previously furnished by Paige himself (*Econ. Geology*, 1923, **18**, p. 205), and by J. O. Hosted and L. B. Wright (*Eng. and Min. Journ.-Press*, May 5 and 12, 1923).

The formation consists of a thick series of slate and schist, striking N.W. and with a steep easterly dip, with intrusions of granite, all of pre-Cambrian age. Porphyry of Tertiary age is found within or adjacent to the ore-bodies, which are mineralised portions of a series of folded beds of definite stratigraphic position—the folds themselves being a series of anticlines and synclines Calcareous and dolomitic schists of sedimentary origin are the ore-bearing rocks. These are invariably immediately or a short distance stratigraphically beneath quartzite. The beds above it (chiefly garnetiferous schists) are everywhere barren of ore. Cummingtonite (iron-magnesium-amphibole) almost invariably accompanies the ore, and at most places cummingtonite rock forms the so-called ore-bearing ledges. The ore-bodies are replacement sulphide lodes, the sulphides being arsenopyrite, pyrrhotite and pyrite—placed in order of introduction—gold being associated with each.

The deposit is regarded by Paige as having been formed in pre-Cambrian time, and enriched during Tertiary time, through the agency of porphyry.

The Homestake, which is one of the greatest gold mines in the world, has been worked to a depth exceeding 2,300 ft.; and by 1922, the tunnels, drifts and crosscuts had attained an aggregate length of 62 miles, and the milling capacity had reached 4,600 tons a day.

Iron

Philippines.—In *Engineering and Mining Journal-Press* of May 2, 1925, under the title of "Mineral Reconnaissance in the Philippines," Hironoa Nishihara refers to the iron ore deposits of the Philippines, which are comparatively small but appear to contain ore of good quality.

The most important deposit is in the Camarines Province on the island of Luzon, and near Mambulao. The main ore-body forms the backbone of the Larup Peninsula and extends farther north to Calambayanga Island. Outcrops of iron ore can be traced in a fairly well-defined continuous line for about 4,500 ft. The ore is non-crystalline and porous near the surface. At some places it is cut by quartz stringers and shows traces of pyrite and chalcopyrite, especially where it is in contact with a dolerite dyke. The thickness exposed appears to average about 12 ft. An average of 32 samples gave the following percentage composition: iron, 63·89; silica, 1·78; aluminium, 6·30; phosphorus, 0·14; sulphur, 0·06; water, 9·27; manganese, 0·31. A rough estimate of the amount of ore in sight is 600,000 tons and a further

138,000 tons on Calambayanga Island. No development of this deposit has yet been attempted.

In Marinduque Island, about 10 miles inland from Maopog on the west coast, is a deposit of magnetite, of which there are exposed about forty large rounded water-worn blocks, some 40 ft. in diameter. On the left bank of the stream is a vertical contact between the magnetite ore-body and country rock, which is diorite.

Manganese

Philippines.—In the article by Hironoa Nishihara referred to under Iron (p. 377) mention is made of a manganese ore deposit about 5½ miles from Aroroy on Masbate Island and not far from the Colorado and Syndicate Gold Mines. The deposit rests immediately on diorite, and is about 10 ft. thick. The manganese ore appears to have been formed by the decomposition of the diorite. Average analyses of samples taken from three different claims show: manganese 47·95 to 50·26, and silica 14·19 to 13·81 per cent., indicating that the manganese mineral is probably braunite.

Oil Shales

Canada.—Analyses showing the amount of oil in shale from Pictou County, Nova Scotia, are given by W. A. Bell (*Canada, Geol. Survey Summ. Rept.*, 1923, Part C2, p. 34).

A bore-hole sunk in the valley of McLellan Brook cut through 1,314 ft. of the Stellarton formation (Carboniferous), which is made up almost entirely of argillaceous shale, but contains bands from a few inches up to several yards in thickness of very dark brown to black shale. Ten bands, from 1 ft. 3 in. to 24 ft. in thickness, were tested, and on distillation yielded from 3·8 to 18·6 gals. of crude oil per short ton. The 24-ft. band yielded only 3·8 gals. of crude oil per ton. One band, at a depth of 245 ft. and 3 ft. 9 in. in thickness, yielded 18·6 gals. of crude oil and 33·6 lb. of ammonium sulphate per ton. Another band, at a depth of 253 ft., was 10 ft. 7 in. in thickness, and yielded 13 gals. of crude oil and 25·5 lb. of ammonium sulphate per ton.

Another bore-hole, put down in the same formation at an horizon several hundred feet below that of the last, disclosed eight bands from 2 to 21 ft. in thickness, which, on distillation, yielded from 5·8 to 12·2 gals. of crude oil per ton. The 21-ft. band yielded only 7 gals., while one 4 ft. 6 in. band at a depth of 603 ft. 6 in. gave 12·2 gals. of crude oil and 27·3 lb. of ammonium sulphate, and another of the same thickness at a depth of 696 ft. 6 in. gave 11·8 gals. of crude oil and 20·3 lb. of ammonium sulphate per ton.

In view of the general low yield of the above samples, representing the most promising-looking horizon from more than 2,000 ft. of the Stellarton formation, it is evident, in the opinion of W. A. Bell, that there is urgent need for further investigation of a precise scientific character before any reliable estimates of the economic value of the oil shales in this district can be made.

Petroleum

Canada.—The following is an abstract of an article by R. T. Elworthy of the Mines Branch, Canada (*Canadian Official Mining News Letter*, No. 47).

The Turner Valley field, Alberta, is the only one in Western Canada where oil has been produced in commercial quantity, though shipments have recently been reported to have been contracted for from the Wainwright field. It is in the foothills of the Rocky Mountains, about forty miles S.W. of Calgary.

Oil of a very light character was first found here in 1914, and since 1916 there has been a production of about 10,000 barrels a year. At present only one well yields oil, but several give large flows of natural gas from which 2 or 3 pints of gasoline per 1,000 cub. ft. can be extracted. Two absorption plants produce yearly about 400,000 gals. of gasoline. The gas after treatment is piped to Calgary to supplement the supply from the Bow Island and Foremost fields. No. 4 Royalite well, commenced in 1922, at a depth of 3,185 ft. yielded over 6,000,000 cub. ft. of gas per day. In 1924 drilling was continued to 3,450 ft., when limestone was reached. At 3,740 ft. gas yielding 21,000,000 cub. ft. per day was struck. After many difficulties the well was got under control. In addition to gas it is reported that the well is yielding 300 barrels a day of light crude oil of sp. gr. about 70° Baumé. If this flow is maintained it will prove the most productive well in the field. It is probable that several new wells will be drilled in the near future.

According to G. S. Hume (*Bull.* 154, *Canadian Inst. Min. and Met.*, Feb. 1925, p. 163), the greatest activity in oil development in Canada during 1924 has centred around the Wainwright–Fabyan–Irma fields in East-Central Alberta. One well, 5 miles north of Wainwright, was brought in as an oil well in 1923. A well (Imperial No. 1) 6 miles west of this "came in" with a gas flow of about 10,000,000 cub. ft., and a showing of heavy oil.

In 1924, another well about five miles north of Wainwright was brought in as an oil well. A gas well, drilled about one mile west of Imperial No. 1, proved to be of a capacity of 2½ million cub. ft. of gas per day, the closed pressure being 700 lb. per sq. in. An oil sand is reported to have been met with below the gas horizon. The structure of the Irma–Wainwright area is supposed to be a terrace. Some of the wells are associated with small folds. The oil of the two oil wells mentioned is a heavy asphaltic base oil of sp. gr. about 14° Baumé.

There has been much drilling activity in Southern Alberta. One well last year " came in " with an open flow of 25,000,000 cub. ft. of gas under a rock pressure of 945 lb. from sandstone of Kootenay age (Cretaceous). There is the possibility of a large gas-field here. The new Foremost gas-field is some miles to the north. The last well sunk by a company here is reported to have yielded nearly 23,000,000 cub. ft. of gas ; it is in three different sands in the Colorado shale, the lowest having a production of nearly 15,400,000 cub. ft. The producing wells have now been connected by means of a 10-in. main with the Bow Island at Burdett, through which gas is being distributed to Calgary and other centres. This field is being developed on a broad dome.

Rumania.—The southern Rumanian oilfields are described by J. Slomnicki and E. Meyer (*Mining Mag.*, 1925, **32**, p. 265).

The Carpathian chain is built up of a series of overthrust masses or " nappes," and to the south of these structures the commercially exploitable oil occurs. The general structures and complex geology of the Carpathians have already been dealt with by G. C. Flower (*Journ. Inst. Petr. Technol.*, 1925, **11**, p. 61). Although oil occurs in Rumania in a very wide range of formations, exploitable deposits are practically confined to the Oligocene and Pliocene beds. The general direction of the anticlines is E.–W. They are rarely more than 5 or 6 miles long, and occur *en échelon*. Miocene Salifer forms the core at the culminating point of the anticlines. The oilfields are usually found around these cores.

Proceeding southwards from the outer overthrust line, three main oil zones are encountered. The northern zone lies along this main line of dislocation, and includes Bustenari, Campina, Pitigara and Gura Diaganeasa fields. Runcu-Chiciura, lying two miles south of this line of overthrusting, belongs tectonically to this zone.

The fields in the second zone are separated from the first by a syncline 10 miles broad, and include the most important fields of Rumania, namely, from west to east, Ochiuri, Gura Ocnitei, Moreni, Filipesti de Padure, Baicoi and Tintea. The largest anticlines and the most pronounced outcropping Salifer cores are found in this region.

The third zone lies still farther south, where comparatively rounded structures prevail. This includes the gas fields of Aricesti and Boldesti, both in the Upper Dacian. So far no oil has been found in this zone. Should this field develop favourably it is probable that the gas will be used in the neighbouring town of Ploesti, a great oil-refining centre.

Bustenari is one of the oldest Rumanian oilfields. The oil is found in the Mæotic and in the Oligocene. The oil occurs at comparatively shallow depths, and the present production is small. The Campina field, 4 miles farther west, has during the last twenty years yielded about 3,000,000 tons of petroleum. The Salifer here has folded the once overlying Mæotic into a small secondary anticline, on the flanks of which large quantities of oil have accumulated. There are wells here that still yield from 20 to 30 tons a day. It is proposed to extract oil from this field by means of shafts and galleries as at Pechelbronn, Alsace-Lorraine. The Runcu-Chiciura fields are two miles south of Bustenari. The structure is a dome, the principal wells occurring in the Mæotic, which overlies the Salifer, and is overlaid by the Pontic. The production of the Runcu field has grown considerably during the last few months. Since the war big gushers giving 1,000 or 1,500 tons a day have at times been brought in. The production of Chiciura is less.

Moreni is the most productive oilfield of the second zone. It contains a very extensive Salifer core striking N.E.–S.W., which has broken through the whole of the Oligocene series. The Dacian formation is the productive rock. The Mæotic is also oil-bearing, but, owing to its great depth, has only been reached in the northern flank of the Salifer core. Tuicani is the most prolific part of the field, where one single well produced 400,000 tons of oil, and where wells yielding 200 or 300 tons a day for several months are known. The Ochiuri field is 10 miles west of Moreni. The oil comes from the Dacian and Mæotic, but the core is a small one. Filipesti de Padure lies 8 miles east of Moreni. The field is situated on a very broad and long anticline. The wells are drilled through lower Dacian and Pontian and produce from the Upper Mæotic at an average depth of 3,000 ft. Midway between Campina and Ploesti there is another Salifer core with the Baicoi oilfield in the west and the Tintea in the east, the wells producing from the Dacian and Mæotic in the former field and from the Dacian alone in the latter, although attempts are being made to reach the deeper-lying Mæotic.

Japan.—The geology of the oilfields of Japan is described by G. Kobayashi (*Econ. Geol.*, 1925, **20**, 67).

The principal petroliferous belts in Japan extend from Hokkaido (Yezo) to Ugo and Echigo Provinces in Honshiu (Hondo), then southward into Shinano Province, disappearing near Nagano City, but reappearing on the Pacific coast of the Totomi Province. The principal oilfields are Hokkaido, Akita (Ugo), and Echigo.

In the Hokkaido oilfields, the important petroleum deposits are found in dark grey shale and grey shale of the Upper Tertiary (Miocene-Pliocene). In the area occupied by the Upper Tertiary, there are many old districts along anticlinal folds. In Ishikari Province, there are two principal anticlinal axes running almost parallel, from north to south. The more eastern (Toshibet anticline) has an axis about thirteen miles in length. The rock consists of shale, the dips on either side being less than 20°. Some of the many wells bored along the anticline produced 250 barrels of oil per day. The parallel Atsuta anticline is 6 miles long. No rich oil-deposit has yet been struck along this fold. Two long anticlinal folds extend south from Kitami Province to Teshio Province. The Koitoi anticline on the east is 17 miles long and is composed of grey shales. Several wells, less than 1,100 ft. deep, reached oil pools here. On the west is the Wakkanai anticline, principally composed of the Wakkanai series of dark grey shales. Fairly rich oil pools have been found in two or three wells here, bored to a depth of 2,500 ft.

The total production of oil in Hokkaido does not exceed 7,000 barrels annually.

In the Akita oilfields, which are parallel to the coast line for about eighty miles, the oil deposits are found in the lower and middle divisions (Miocene) of the Upper Tertiary. In the lower division, the upper parts of the siliceous shale series, and, in the middle division, the lower parts of the grey shale series, contain oil. The oil deposits are confined to the anticlinal or domal structures. The Kurokawa oilfield which produced a gusher (see Imperial Institute Monograph *Petroleum*, 1921, p. 58) has an elongated dome structure. In the Toyakawa black shale field the structure is that of a terrace. The Michikawa field is in grey shale, which forms an elongated north-trending dome. In the Uchimichikawa field the structure is anticlinal.

In the Echigo oilfields the principal oil-bearing stratum is a tuffaceous sandstone (" shiro " or white stone) which varies from 20 to 500 ft. in thickness, and which belongs to the lower black shale series (Miocene) of the Upper Tertiary. All the oil districts scattered throughout the region are on anticlines, especially on those having an elongated dome structure.

The oil from the various horizons varies in specific gravity from 10° to 50° Baumé, the poorer oil coming from the higher strata. The oil is believed to have originated in the black and dark grey Tertiary shales, which contain much organic matter.

The production, which has been declining since 1915, amounted to 2,447,000 and 2,004,000 barrels in 1921 and 1922 respectively.

Silver

United States.—The silver-bearing quartz veins and stockworks of the Rochester District, Nevada, are described by Adolph Knopf (*Bull. 762, U.S. Geol. Survey*, 1924).

The chief productive silver veins are on Nenzel Hill, and crop out in rhyolite breccia or in the overlying stratified rhyolite tuff. At a moderate depth the veins pass into felsite (altered trachyte). The veins are of the replacement fissure type and are, on an average, about 3 ft. in thickness. The filling consists mostly of fine-grained quartz scattered with minute grains of pyrite, and with many small blackish patches of argentite. In the deeper levels there are bluish-black mottlings, being mixtures of argentite and covellite, and blende, with some galena, tetrahedrite and chalcopyrite. The veins have been mined to a vertical depth of 800 ft. below the outcrop, at which depth they proved unpayable. Above the 300-ft. level the ore carried 60 oz. of silver, and below that level 10 to 12 oz. of silver per ton.

The argentite and covellite are secondary. The former often replaces blende. The wall rocks have been altered by silicification; much of the quartz gangue of the veins is due to the replacement of the country rock.

The east and west veins of Nenzel Hill, worked by the Rochester Mines Co., have so far yielded most of the silver that has come out of the hill. Spangles of native silver are found in the east vein occasionally, even as deep as the 800-ft. level (tunnel or deep adit).

Stockworks have furnished the bulk of the ore in the

Nevada Packard mine in the southern part of the district. They are roughly elliptical in form and consist of a widely spaced network of narrow veinlets or seams in rhyolite, which carry finely disseminated cerargyrite with sericite as the only conspicuous gangue, but the ore gives out at a depth of 30 ft. or less.

The ore mined has contained about 8 oz. of silver per ton.

The striking feature of the Packard Ridge is the widespread dispersion of the silver, and its concentration in sporadic shallow bodies of ore.

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NOTICES OF RECENT LITERATURE

THE BRITISH COMMONWEALTH AND ITS UNSOLVED PROBLEMS. By C. M. MacInnes, B.A. Pp. x + 176, 7¼ × 4¾. (London: Longmans, Green & Co., 1925.) Price 5*s.*

In the introduction to this book the author expresses his faith in the future efficacy of the League of Nations as an establisher of a saner world-order. Before this end can be achieved the League must be nursed by strong friends none of whom is more fitted for the purpose than the British Empire, itself already a League of Nations. The chief problems with which the League has to deal arise from unbridled nationalism and form the theme of this book.

The earlier chapters discuss the relationship between the self-governing Dominions and the Mother Country, as well as the international position of the former. Grievances are considered and suggestions made for future betterment. Chapter IV deals with the principle of trusteeship for " child-races." In Malaya and the East African Colonies and Protectorates the task is as far as possible to preserve native institutions while purging them of barbarism. In the West Indies the problem is more complicated. From one section comes the demand for responsible government, from another for federation.

Four chapters are next devoted to the Indian question. After tracing the evolution of dyarchy the author describes some of the principal causes of unrest in India and the part played by Mr. Ghandi in giving practical expression to the discontent. The relationship between India and the Protectorates and Crown Colonies, particularly Kenya Colony, is discussed, and finally that between India and the Dominions.

After a short chapter in which the author sums up his conclusions, the book ends with a brief list of authorities and parliamentary papers.

The problems dealt with in this book are of such magnitude that the author has only been able to present them in outline. It is strange that no reference is made to the future relationship between white and black races in South Africa, by no means the least of problems. Apart from this omission, the book contains a large amount of valuable information and deserves to be widely read.

THE WEST INDIES. By George Manington, F.R.G.S. Pp. xvi + 304, 8½ × 5½. (London: Leonard Parsons, Devonshire Street, 1925.) Price 15*s*.

The book contains a very readable general description of the nature, history, products and peoples of the West Indian islands, British and otherwise, and also of British Guiana and British Honduras. Labour conditions past and present are discussed, together with the difficult question of the education of the coloured races and the relationship of the British West Indies to the Mother Country. Administrative and political questions are also discussed in the interesting foreword contributed by the Rt. Hon. Baron Olivier.

Several of the facts stated by the author appear open to question, as, for example, that balata forms " the chewing-gum so popular in the United States," no mention being made of chicle. The statement that gratings of the coconut kernel are made into " a coconut milk " is also questionable. Neither is it a " well-founded belief " that Tobago was the scene of Alexander Selkirk's shipwreck.

Misprints are somewhat numerous. In the description of the destruction of Martinique, the *Roddam* figures also as the *Rodney*, while in the chapter upon animal and insect life " armadilla " and " companero " are both errors, although correctly given in the index. It is also somewhat amusing to read that Antigua is subject to frequent " draughts " !

The book, which, in spite of defects, is very interesting, is furnished with 17 illustrations, and with a small general map.

NORTH AMERICA. By J. Russell Smith, Professor of Economic Geography, Columbia University. Pp. viii + 849, 8¾ × 5¾. (New York: Harcourt, Brace & Co., 1925.) Price: Library Edition, $6.00; Text Edition, $4.75.

A sub-title to this volume explains that it describes the people of North America and " the resources, development and prospects of the continent as an agricultural, industrial and commercial area." This well indicates the scope of the work, but gives no idea of the comprehensive and illuminating manner in which Professor Russell Smith traces the evolution of North American civilisation under the white race and describes the present economic condition of the region (including Mexico, Central America and the West Indies). The arrangement, appearance and style of the book are in every way admirable, and its interest and utility are enhanced by numerous maps, diagrams and illustrations. An excellent physical and regional map is also provided as a loose inset.

The author's main object, as explained in a prefatory note, is to assist in giving young Americans " a thorough knowledge of the continent on which they are to live." It may, however, safely be said that no one with the least interest in economic geography and the factors which determine national and industrial development in various parts of the globe, will regret the perusal of this authoritative treatise.

KAKAO. By Professor Dr. Traugott Zeller. Pp. ii + 165, 7 × 4¾. (Hamburg: Walter Bangert, 1925.) Price Mk. 5.

This is the first of a series of monographs on agriculture in the tropics, edited by Dr. Walter Busse and dedicated to the memory of Ferdinand Wohltmann, whose life-work was inseparably connected with the advancement of tropical agriculture.

The book gives a concise account of cocoa and its production, including the different varieties and types of the tree, its propagation, the climatic and soil conditions required for its satisfactory development, the methods of cultivation, manuring and harvesting, the pests and diseases by which the tree is liable to be attacked, and the costs of production and the profits obtainable. A good description is provided of the methods of fermenting and drying the cocoa, and of its physical and chemical properties and the different grades which appear in commerce. Statistics are furnished of the world's production and consumption, and a short list of the principal literature of the subject is appended.

The work is well and clearly written and forms a useful textbook.

PECAN-GROWING. By H. P. Stuckey and Edwin Jackson Kyle. Pp. xiii + 233, 7½ × 5. (New York and London: The Macmillan Company, 1925.) Price 12*s.* 6*d.*

This book on pecan-growing is one of the Rural Science Series issued under the editorship of Mr. L. H. Bailey, the well-known authority in the United States on agricultural and horticultural matters. It deals with the history of the subject and also gives information regarding the methods of propagating the pecan tree; the soil and fertilisers most suited to the crop; the methods of planting, harvesting, preparing and marketing the nuts; particulars of the insect pests and fungal diseases to which the trees are liable, and methods of control; and a description and classification of the varieties of the pecan, some 35 in number, which have been evolved as a result of cultivation and cross-fertilisation.

The pecan nut is derived from *Carya* (*Hickoria*) *Pecan*, a tree closely allied to the walnut, and one of the group of species known as "hickories" in the United States where they are native. The pecan, which is one of the largest of the hickories, is indigenous to the valley of the Mississippi and its principal tributaries; the valleys of the more important rivers of Texas and Oklahoma; and the northern and central parts of Mexico. It is now cultivated, not only in those States to which it is indigenous, but over an area extending from the Atlantic Coast to the western part of Iowa, Oklahoma and West Texas; also in some of the Pacific States, especially California. The production of pecan nuts in the United States in the year 1919 was nearly 32 million pounds, and it is stated that the next decade will probably see a greatly increased output in view of the large number of trees of improved varieties which have been planted and which are about to come into bearing. Marketing Associations such as the National Pecan Growers' Exchange, a co-operative association working by means of sub-exchanges throughout the producing areas, control the curing, grading and marketing of the nuts in the United States. Pecan nuts are used chiefly as dessert nuts and in confectionery. They are occasionally seen on the London market, and the demand for them would undoubtedly increase were supplies of the improved varieties forthcoming

Growers of pecans should find this book of much interest, and intending cultivators of the tree in countries outside the United States where suitable climatic conditions prevail could not do better than consult its pages, which contain the latest available information based on the wide and practical experience of the authors.

DER SISALBAU IN DEUTSCH-OSTAFRIKA. By Dr. Richard Hindorf. Pp. viii + 171, 9½ × 7¼. (Berlin: Dietrich Reimer (Ernst Bohsen), 1925.) Price 6*s.* 6*d.*

The author of this work is probably the greatest living authority on the subject of Sisal hemp cultivation. He first suggested this crop to the German East Africa Company in 1892 for cultivation in Tanganyika (then German East Africa), and in the following year, after overcoming various obstacles and difficulties, succeeded in obtaining a small consignment of Sisal hemp plants from Florida. Of these plants, those which had survived the journey were set out on a plantation at Kikogwe, but only 62 grew satisfactorily. Their careful cultivation and multiplication from suckers and bulbils, however, have given rise to the numerous plantations which now cover enormous areas in Tanganyika. Dr. Hindorf has been in close touch with the industry throughout its development and is therefore exceptionally well qualified to deal with every phase of the cultivation of the Sisal agave and the extraction of the fibre and its preparation for the market.

These subjects are fully dealt with in the present book, which can be confidently recommended to all those engaged in Sisal hemp cultivation and will be especially valuable to planters in East Africa.

DIE GERBSTOFFE UND GERBMITTEL. By H. Gnamm, Chemie in Einzeldarstellungen, XII Band. Pp. 394, 9½ × 6¼. (Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1925.) Price 24 gold marks.

The author has given in a concise form a summary of the chemistry and the more important facts relating to the occurrence, preparation and utilisation of tanning materials of both organic and inorganic origin. The term "tanning material" has been interpreted in a wide sense, but tans of commercial importance are clearly distinguished from those of only scientific interest. A short introduction deals with the theory of tanning and gives an outline of the processes involved in the preparation of leather. The book is divided into three main parts; the first, by far the longest, dealing with vegetable tanning materials, is subdivided into sections on the pyrogallol group, the pyrocatechin group, a group of materials of undetermined constitution, and a section on naturally occurring substances related to tans. The second part of the book is devoted to mineral, and the third to synthetic, tanning materials.

THE TECHNOLOGY OF WOOD DISTILLATION, with special Reference to the Methods of obtaining the Intermediate and Finished Products from the Primary Distillate. By M. Klar, translated by Alexander Rule, M.B.E., D.Sc. (Liv.), Ph.D. (Jena), F.I.C. Pp. xv + 496. (London: Chapman & Hall, Ltd., 1925.) Price 25s.

This book is a translation of the second edition of Klar's well-known work, which deals in a comprehensive manner with the methods employed in the destructive distillation of wood and the separation and purification of the products.

The original text has been translated with but little alteration, but some new matter has been introduced, including an account of the manufacture of "iron liquor," and descriptions of the continuous mechanical retort used in certain parts of this country and the Ross and Corner vertical retort for distilling small waste. The official specifications for acetone and wood naphtha have been revised as necessary, and new methods of analysis have been embodied in the analytical section.

A chapter has been added dealing with recent progress, particularly with reference to improvements in plant for refining the distillation products and to new processes for distilling small waste wood, sawdust and other waste materials, such as coconut shells, wattle waste and myrabolans kernels; in the latter connection the Seaman process and the Stafford process are described, and an account is given of the Poore process in which a cylindrical rotary retort is used, heated externally and fitted internally with perforated pipes for conveying superheated steam to the charge. Additional data are furnished on the yields of the distillation products of a large number of Indian woods and other materials, and reference is made to recent investigations into the possibilities of increasing the yields of acetic acid and methyl alcohol.

The work contains a number of excellent diagrams and will be of great service as a standard work on the subject of wood distillation and its products.

ORGANIC DERIVATIVES OF ANTIMONY. By Walter G. Christiansen, Instructor in the Harvard Medical School. Pp. 230, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1925.) Price $3.00.

This work, which has appeared in the American Chemical Society Series of Scientific and Technologic Monographs, is dedicated to Professor Elmer P. Kohler. Its preparation was undertaken in connection with a study of antimonials which is being made in the Departments of Pharmacology and Tropical Medicine at the Harvard Medical School.

The use of organic antimonial compounds for the treatment of protozoan diseases has recently been the subject of numerous researches, as it has been found that, in certain cases, antimonials are much more efficacious than arsenicals. The results of these researches have appeared in various papers scattered through scientific literature, but hitherto there has been no comprehensive compilation dealing with the subject in a systematic manner. The author has therefore collected the published data and correlated them in such a way as to render them readily available, and suitable both for those desiring a general knowledge of the organic antimony derivatives and for those undertaking research work in this sphere. In order to achieve this aim, the work is divided into two parts, the first being devoted to a general discussion of the chemistry of the organic derivatives of antimony, whilst the second deals in detail with the methods of preparation and the constitution and properties of the various compounds. The last chapter of the book gives an account of methods of analysis of these substances.

A chapter on " Antimonials as Therapeutic Agents," which has been contributed by George S. Shattuck, M.D., treats of the tropical diseases in which such compounds are of special value, viz. diseases due to trypanosomes, to protozoan parasites of the genus Leishmania, and to flat worms or " flukes " of the genus Schistosoma, and the diseases of leprosy and inguinal granuloma.

The work is well written, contains a full bibliography, and is admirably fitted for the purposes it is intended to fulfil.

ANATOMY AND PHYSIOLOGY OF THE HONEY-BEE. By R. E. Snodgrass. Pp. xv + 327, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1925.) Price 17*s*. 6*d*.

This book is the latest addition to the excellent series of McGraw-Hill Agricultural and Biological Publications, edited by Charles V. Piper.

The author, who is officially connected with the Office of Bee Culture in the United States Bureau of Entomology, has given a very complete account of the structure and life-history of the honey-bee. In order that the anatomy of the bee may be rightly understood in its relation to that of other insects, an indication is given of the manner in which its special needs have been met by adaptations of general insect structure. The various chapters are therefore introduced by a description of a lower member of the Hymenoptera or of some other insect, such as a grasshopper or a cricket, or by a general survey of the history of an organ, before discussing the particular subject in relation to the bee itself. The effect of this is not only to make the book more interesting and to facilitate the study of the honey-bee, but also to render the work useful as a general introduction to entomology—an object apparently not contemplated by the author.

The volume contains much original matter derived from the author's own work in the Bureau of Entomology, and is profusely illustrated with excellent diagrams. It contains a useful bibliography and forms a comprehensive and up-to-date treatise on the subject.

AN INTRODUCTION TO PHYSICAL GEOLOGY, WITH SPECIAL REFERENCE TO NORTH AMERICA. By William J. Miller. Pp. xvi + 435, 8¾ × 6. (London: Chapman & Hall, Ltd., 1925.) Price 13*s*. 6*d*.

This useful elementary book is issued as a companion volume to the author's *Introduction to Historical Geology*, the two together being intended to serve as the basis of a one-year college course in general geology. The treatment of the subject is simple and logical, and the descriptions clear and interesting. Minerals and rocks are considered first, then follow chapters on rock weathering, the earth's crust, the work of streams, glaciers, the wind and the sea. Other subjects dealt with are vol-canoes, underground waters, mountains, plains, lakes and economic geology. Special attention is given to the description of the work of streams, a proper understanding of which is regarded by the author as of prime importance to students of physical geology. The illustrations are numerous and excellent, many of them being reproductions of photographs taken specially for this book. The style of the book is altogether good, and does credit to both author and publisher.

ENGINEERING GEOLOGY. By H. Ries, Ph.D., and Thomas L. Watson, Ph.D. Third Edition, Revised. Pp. vii + 708, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925.) Price 25*s.*

About ten years have elapsed since the issue of the second edition of this useful textbook, the aim of which is to provide a special course of study in applied geology for the use of students of civil engineering. The book has been slightly enlarged, rewritten in parts and brought up to date. Otherwise it retains its previous form and the illustrations are practically the same.

THE MARKETING OF METALS AND MINERALS. A Series of Articles by Specialists, edited by Josiah Edward Spurr and Felix Edgar Wormser. Pp. xii + 674, 9 × 6 (New York and London: McGraw-Hill Book Co., Inc., 1925.) Price 30*s.*

This useful book fills a gap in mining literature. It contains 64 articles—the majority of which have already appeared in the *Engineering and Mining Journal Press*—covering 92 distinct metals and minerals which have a marketable value. A great many of the articles not only describe in considerable detail the actual marketing, but deal briefly with the history, uses, modes of occurrence and methods of mining and treatment of the particular metal or mineral under discussion. A good many of the articles are practically confined to deposits occurring in the United States, such as those on slab zinc (spelter) and zinc concentrates, and aluminium, among metals, and those on high-grade clay, coal, diatomaceous earth, felspar, garnet, gypsum, slate, sulphur, etc., among non-metallic minerals. The article on phosphate rock is practically confined to the deposits of Florida and Tennessee, and that on tripoli refers mainly to the mineral of Seneca, Missouri. On the other hand, the article on asbestos refers to Canadian asbestos only, and that on sodium nitrate is confined to Chilian nitrate.

All the articles are valuable and well written, but those on chromite by Edward Sampson, copper by Edward H. Robie, and gold by Felix Edgar Wormser are especially illuminating, while one of the most interesting and comprehensive articles is that on gem stones by George F. Kunz. J. H. Lang writes on tin in a humorous vein. Referring to the London Metal Exchange he says : " London derives the larger part of its business and almost the whole of its inspiration from the United States, which does not get so much as a split commission out of it." This will be news to some.

There are a few misprints, omissions and errors. On page 258 we are that told the element beryllium was first known in 1917—the date should be 1798. In the article on vanadium by Frank L. Hess, the " imperfectly known mica-like mineral " said to be associated with carnotite in Colorado and Utah is presumably roscoelite. Zirkite is given as the trade name for brazilite or baddeleyite, but the writer of the article—H. C. Meyer—has elsewhere (*Min. Res. U.S.*, 1916, Pt. II, p. 377) stated that the commercial ore of zirconia (" zirkite ") consists of a mixture of brazilite, zircon and a new unnamed silicate of zirconium.

THE METALLURGY OF ALUMINIUM AND ALUMINIUM ALLOYS. By Robert J. Anderson, B.Sc., Met.E. Pp. xxxi + 913, 9¼ × 6¼, (New York : Henry Carey Baird & Co. Inc., 1925.) Price $10.

According to the author, this treatise is designed to serve as a textbook of aluminium metallurgy, not only for engineering students, but for those engaged practically in work allied to engineering and metallurgy. The earlier chapters are concerned with the history of the aluminium industry ; its present status ; aluminium production by countries ; market and trade statistics and aluminium tariffs ; bauxite and related minerals ; and bauxite mining. The bauxite deposits of the world are very briefly described, but no mention is made of the important deposits of high-grade varieties in the Gold Coast Colony.

The various processes for obtaining metallic aluminium receive attention, and it is shown that, so far, the Hall-Heroult still holds the field. The larger part of the book is concerned with the description, properties and uses of aluminium and its alloys. Much of the information has been published in this country in the form of various research reports on alloys by Dr. W. Rosenhain and others, but the author has collected and summarised this information and added a considerable quantity of valuable new matter. A chapter on " Casting Losses, Defects in

Casting and their Prevention" and another on "Soldering and Welding Aluminium and Aluminium Alloys," should be of considerable value to aluminium founders and workers.

Generally, this treatise is probably the most complete work on aluminium and its alloys yet published in any language, and it brings the subject practically up to date. But, as the author points out, the current rapid developments in aluminium metallurgy are likely to render obsolete at an early date the standard processes of to-day. The book is profusely illustrated, and its usefulness is increased by numerous references in the text to a bibliography at the end of each chapter.

THE STORY OF COPPER. By Watson Davies, C.E. Pp. xix + 385, 8 × 5. (London: T. Werner Laurie, Ltd., 1924.) Price 12*s.* 6*d.*

This book aims at giving an account of copper suitable to the requirements of non-technical readers. It is written in very simple language, but deals with the subject in a remarkably comprehensive and scientific way. The various chapters deal with the history of copper, its minerals, the geology of its ores and their distribution, mining and metallurgy, and the physical and chemical properties of the metal. The various uses of copper are enumerated and many detailed descriptions are given. For those who desire fuller information, the author supplies a number of useful and descriptive references. The book can be recommended to anyone who wishes to have a readable and interesting account of copper.

NON-METALLIC MINERALS. OCCURRENCE—PREPARATION—UTILISATION. By Raymond B. Ladoo. Pp. viii + 686, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 30*s.*

This is a useful compilation of data collected by the author while he was engaged in non-metallic mineral investigations for the United States Bureau of Mines.

The various minerals and groups are dealt with in alphabetical order, and, so far as the principal ones are concerned, each is described under the headings, composition, general description, physical properties, occurrence and distribution, production and consumption, mining and milling, markets and prices, grades and specifications, utilisation, bibliography.

In order to limit the size of the volume, fuels and other natural hydrocarbons have been omitted and the sections on some of the larger groups, such as stone, cement, clays, and some of the precious stones, have been much restricted; but nearly all the economically important non-metallic minerals have been included.

The omission of much matter that it was originally intended to include, especially that relating to deposits other than American, has resulted in a noticeable lack of balance. The sections dealing with minerals principally produced in the American continent are, as a rule, considerably longer and more detailed than those dealing with minerals most largely mined elsewhere, and deposits in the United States are sometimes given considerable space, almost to the exclusion of notable foreign occurrences. Examples of this are the chapters on salt, strontium minerals and phosphates. In the chapter on diatomaceous earth there is no mention of the deposits in Victoria, Australia, or of the occurrences in the Rift Valley of East Africa. Indian bauxite is barely mentioned and the important memoir by C. Fox on this subject is not included in the bibliography.

The illustrations, which consist mostly of flow-sheet diagrams, provide a noteworthy feature. The bibliographical references are numerous and fairly up to date. The book is one that can be recommended as a useful work of reference to all who are interested in the technology of non-metallic minerals.

COAL AND CIVILISATION. By E. C. Jeffrey, Ph.D., S.D., LL.D. Pp. xvi + 178, 7½ × 5¼. (New York: The Macmillan Co., 1925.) Price 10s. *6d.*

This is a book of considerable interest, written in an attractive style. Notwithstanding the title, only the first two and the last of its 16 chapters appear to be germane to the subject of coal and civilisation. The remaining and more important chapters are concerned with the sources, the processes of formation and the nature and structure of the various types of coal and related substances.

The Latin countries of Europe, as well as the energetic Scandinavian peoples, are quoted as examples of nations handicapped industrially by deficient coal resources. With less reason, France is also included in this category. It would seem that French coal resources, if more intensively exploited, are sufficient to form the basis of a great industrial development for a long period.

The final chapter contains the interesting statement that the known coal reserves of the world ensure a supply for 6,500 years on the basis of the consumption for 1910. While current consumption is, and future consumption doubtless will be, on a much greater scale, the author sees no reason for the present generation foregoing any advantage that coal utilisation can give.

The case of petroleum reserves is different, and exhaustion is likely to be reached in a mere fraction of the above period. The author does not appear to be optimistic regarding proposed petroleum substitutes. Coal carbonisation as a source of liquid fuel is considered inadequate, while it is thought that crude oil must reach a price of about five dollars a barrel to make oil shale exploitation commercial. The other methods which have been proposed for producing liquid fuel are not discussed.

Those concerned with fuel questions will find much to interest them in this book.

THE CONSTITUENTS OF COAL TAR. By Percy Edwin Spielmann, Ph.D., B.Sc., F.I.C., A.Inst.P., A.R.C.Sc. Pp. xii + 219, 8½ × 5½. (London: Longmans, Green & Co., 1924.) Price 12*s*. 6*d*.

This book is one of the series of Monographs on Industrial Chemistry edited by the late Sir Edward Thorpe. The object of the book, as stated in the preface, is to be of service to chemists who are interested in the individual substances which together form coal tar. A knowledge of the fundamental principles of organic chemistry is assumed and the well-known properties of the commoner coal tar constituents are not recorded.

The book is divided into five parts. Part I deals briefly with various types of tar and with the general characteristics of the different classes of compounds occurring in them. The remaining parts consist respectively of detailed descriptions of the individual substances, under the headings of hydrocarbons, oxygen compounds, sulphur compounds and nitrogen compounds.

The descriptions deal fully with the physical constants, and in each case include methods of preparation of the pure substance from coal tar, its quantitative estimation, and its more important properties and uses.

A complete list of the large number of papers referred to in the book is appended.

TROPICAL GARDENING AND PLANTING, WITH SPECIAL REFERENCE TO CEYLON. By H. F. Macmillan, F.L.S. Third Edition. Pp. xvi + 594, 8¾ × 5¾. (Colombo and London: The Times of Ceylon Co., Ltd., 1925.) Price 37*s*. 6*d*.

Although this well-known handbook has been prepared with special reference to Ceylon, it covers such a wide field and treats of such a large number of plants that, with due allowances for climatic and seasonal differences, much of the information is applicable to tropical countries generally. The third edition, which is enlarged, and to a large extent rewritten, has been keenly awaited for some time, and this is not only evidence of the value of the book, but also of the prevalence of a taste for gardening amongst European residents in tropical countries. As Superintendent of the Royal Botanic Gardens at Peradeniya, the author has had unique opportunities for acquiring a practical knowledge of the cultural requirements of a vast number of both ornamental and useful tropical plants ; for Ceylon has not only a rich indigenous flora, but many exotic species have proved amenable to cultivation in the various climatic zones of the island. Ceylon is, moreover, a centre for the production of a number of plantation products of the first importance.

Into this volume of nearly 600 pages the author has compressed a large amount of information which would have occupied far greater space but for the system of classification and arrangement adopted. This system consists in dividing the book into sections, each treating of one of the various aspects of the subject, and of classifying the plants dealt with under chapter headings according to their nature or uses, space being saved by cross-references where a subject appears under more than one heading. To many people, especially to amateurs, this method of arrangement will be found more convenient than the alphabetical arrangement usual in gardening dictionaries and encyclopædias. Consultation is further facilitated by a very full index of some 20,000 references.

Section I deals with the principles underlying horticulture and the methods of cultivation practised in the tropics ; whilst Section II is devoted to descriptions of plants grown for purely ornamental purposes. Tropical and sub-tropical fruits, vegetables and spices are described in Section III, and the number of fruits dealt with under this heading is suggestive of the large field open to the plant-breeder ; for the author points out that very few of the numerous tropical fruits have, so far, undergone improvement as a result of cultivation, hybridisation or selection. Section IV is the most important from the planter's point of view, as it deals with such important plantation crops as tea, coffee and cocoa ; cane-sugar and palm sugars ; tobacco and drug plants ; areca and kola nuts ; oil-seeds, such as castor, coconut, sesamum and sunflower ; essential oils ; camphor ; rubber, gutta, and other plant secretions ; fibres of various kinds ; tans and dyes; and fodders. A description is given of the plants comprising each of these groups together with a concise account of methods of cultivation and propagation, and the preparation of the various commercial products derived from them.

The information regarding economic products might in several instances have been more precise; for example, it is stated of *Agathis australis*, the Kauri Pine of New Zealand (p. 96), that it " yields valuable timber and kauri gum in its native home, where some 15,000 tons a year of the gum are collected for the extraction of oil. The latter yields a motor spirit and turpentine." The bulk of this kauri gum is, in fact, obtained by digging from swamp lands where no living kauri trees now exist, and it is used chiefly in varnish and linoleum manufacture. The oleo-resin obtained from living trees is a comparatively small amount and has different properties from the " gum." In describing *Ceratonia Siliqua,* the carob or locust bean tree (p. 275), no mention is made of the fact that Cyprus is the principal country exporting carob beans; and it is not by cuttings, as stated, but by grafting that fruiting trees are usually obtained.

The concluding section deals with insect and fungoid pests, and the means of controlling them, together with much miscellaneous information, and a glossary of technical terms. The proofs appear to have been carefully read, for very few typographical errors are apparent, but occasionally there is a deviation from customary spelling, such as chickle for chicle (p. 410), and Ailantus for Ailanthus (p. 96).

The book contains about 400 illustrations, mostly from the author's photographs, and these add considerably to its value as a work of reference.

From what has been said it will be gathered that this handbook should prove of great use to all who reside in, or have interests in, tropical countries, whether they look upon plants as ornaments in gardens, or from a purely utilitarian point of view as producers of food or products of commercial value. To all such it provides, in a concise and convenient form, information that would need a considerable library to supply if contained in separate works specifically treating of the numerous subjects dealt with.

BOOKS RECEIVED

Malayan Trade Annual, 1925. Edited by Philip C. Coote. Pp. 123, 8½ × 5½. (London: Sampson Low, Marston & Co., Ltd., 1925.) Price 3*s.* 6*d.*

Crop Production and Soil Management. By Joseph F. Cox, B.S.A. Pp. xxx + 516, 8¼ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925.) Price 13*s.* 6*d.*

Coffee. A Monograph of the Economic Species of the Genus "Coffea" L. By Ralph Holt Cheney, M.A., M.S., Sc.D. Pp. xvii + 244, 9¼ × 6¼. (New York: The New York University Press, 1925.)

Commercial Feeds. A Handbook for the Buyer and Seller. By W. H. Strowd, Ph.D. Pp. vii + 288, 7¾ × 5¼. (Madison, Wisconsin: The Strowd Company, 1925. Price $3.00.

Crop Production, Poisoned Food and Public Health. By John Hepburn. Pp. xxiii + 131, 7¼ × 5. (London: Crosby Lockwood & Son, 1925). Price 7*s.* 6*d.*

A Course of Metallurgy for Engineers. By F. C. Thompson, B.Sc., D.Met. Pp. 240, 8½ × 5½. (London: H. F. and G. Witherby, 1925.) Price 25*s.*

Molybdenum, Cerium and Related Alloy Steels. By H. W. Gillett and E. L. Mack. Pp. 299, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1925.) Price $4.00.

Shale Oil. By Ralph H. McKee, Ph.D., LL.D. Pp. 326, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1925.) Price $4.50.

The Conversion of Coal into Oils. By Dr. Franz Fischer. Authorised English translation edited with a foreword and notes by R. Lessing, Ph.D., F.C.S., M.I.Chem.E., M.Inst.P.T. Pp. 284, 9¾ × 7½. (London: Ernest Benn Limited, 1925.) Price 36*s.*

Dizionario di Merceologia e di Chimica Applicata. By Professor Dr. G. Vittorio Villavecchia in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi, Dr. A. Bianchi and Dr. R. Belasio. 4th edition. Volume III, Naftalina–Sena. Pp. 419, 10 × 7. (Milan: Ulrico Hoepli, 1925.) Price L. 35.

A CATALOGUE OF BRITISH SCIENTIFIC AND TECHNICAL BOOKS. New Edition, entirely revised and enlarged. Pp. xxii + 489, 8½ × 5½. (London: The British Science Guild, 1925.) Price *12s. 6d.*

GENERAL ZOÖLOGY. By H. L. Wieman. Pp. ix + 312, 9¼ × 6¼. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 15*s.*

BACTERIOLOGY: A TEXT BOOK ON FUNDAMENTALS. By Stanley Thomas, M.S., M.A. Pp. xiii + 201, 9¼ × 6¼. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 12*s.* *6d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

INVESTIGATIONS OF ESSENTIAL OILS

1. CAMPHOR LEAVES AND TWIGS FROM UGANDA

THE material which is the subject of this report was forwarded to the Imperial Institute by the Conservator of Forests, Uganda, in March 1925. It was stated that the leaves and twigs were taken from trees experimentally grown by the Forestry Department on a small plantation near Entebbe, and it was desired to ascertain the yield of camphor obtainable from them.

The sample consisted of twigs with leaves attached, and also some loose leaves. The twigs measured from 1½ to 2 ft. in length and up to ¼ in. in diameter.

The material as received contained 11·8 per cent. of moisture, and on steam distillation yielded 2·3 per cent. of pale cream-coloured, almost solid, volatile oil, equivalent to a yield of 2·6 per cent. from the moisture-free material. On cooling the oil and pressing out the still liquid portion, about 70 per cent. of white solid camphor (melting at 178° C.) was obtained, equivalent to a yield of 1·6 per cent. from the leaves and twigs as received. A further quantity of solid camphor would be obtainable from the residual oil (by distillation), but the material received was insufficient for experiments to determine the actual amount thus recoverable. The total yield of camphor may, however, be taken as about 1·8 per cent.

For comparison with the foregoing results, the following recorded yields for oil and camphor from the leaves of camphor trees from various sources may be quoted:

Country of Origin.	Condition of Leaves.	Yield of Oil. *Per cent.*	Yield of Solid Camphor. *Per cent.*
Tanganyika	Dry	2·0	1·5
India (1)	Dry	2·4 to 4·[illegible]	0·1 to 1·3 (crude)
„ (2)	Dry	—	1·2 to 2·0[1]
Jamaica	Dry	—	2·5 (crude)
Malay States	Air-dried	1·1 to 1·2[2]	—
Italy	Dry	—	2·4 to 3·0
Florida	Green	—	1·1 to 2·1 (crude)
Uganda (present sample)	Air-dried	2·3	1·6[3]

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[1] *Crude camphor plus that obtained by distillation of oil from which the crude camphor had separated.*

[2] *Consisting almost entirely of camphor.*

[3] *Excluding camphor dissolved in the residual oil.*

The results of the investigation show that these camphor leaves and twigs from Uganda yielded 2·3 per cent. of oil or about 1·8 per cent. of solid camphor. These yields agree generally with those recorded for camphor leaves from other sources, as shown by the figures quoted above.

On the basis of these results, the yield of crude camphor from one ton of the leaves and twigs would be about 40 lb., which at the price of Japanese crude camphor (2*s.* 6*d.* per lb. in London in December 1925) would be worth £5. The residual oil left after the extraction of the camphor would probably resemble other camphor-leaf oils in containing no safrole and would only be saleable at a low price as a turpentine substitute.

If the camphor oil were marketed without extracting the camphor, its value (for camphor) would probably be about 2*s.* per lb. under present conditions.

The preparation of camphor from the leaves of *Cinnamomum Camphora* as a commercial enterprise has been carried out in Florida, United States of America, where two companies commenced operations some years ago and a few thousand pounds of camphor were prepared and marketed. It seems, however, to have been found impossible to produce the camphor sufficiently cheaply to compete successfully with imported Japanese camphor and the synthetic product, and it was stated in 1922 that the operations had been abandoned.

In view of the present comparatively low price of camphor, and the rather small yield furnished by camphor leaves, it is perhaps doubtful whether the enterprise would prove a very profitable undertaking in Uganda, although the labour conditions are probably more favourable than those obtaining in Florida. The question, however, is worth consideration, as certain essential oils which are now being produced successfully on a commercial scale are obtained in yields similar to that of camphor from camphor leaves and realise similar market prices.

2. Massoi Bark from Papua

Two samples of massoi bark from Papua have been received at the Imperial Institute. The first, sent by the Director of Agriculture in 1923, was submitted to preliminary examination in order to determine the nature of the oil which the bark yields, whilst the second was sent by Mr. C. E. Lane-Poole in November 1924, at the suggestion of the Institute in order that a more complete examination of the oil might be made. At the time the first sample was sent the botanical identity of the tree from which the bark was obtained was not definitely known, but Mr. Lane-Poole stated that the second sample was the bark of *Cinnamomum Massoia*, Schewe.

According to information kindly furnished by Mr. Lane-Poole, massoi bark was exported from Papua to Malaya in very early times, indeed before the advent of the white man. Mr. Lane-Poole states that the bark is obtained from two or three species of *Cinnamomum* (one of which, however, may be merely a variety), which have a wide distribution in New Guinea, having been found by him all round the island from the Gulf of Papua to the Sepik river, as well as in the neighbouring islands of New Hanover and New Ireland. Wherever the tree occurs the bark is well known and used by the natives medicinally, usually to cure fevers, and for other purposes. The largest species is a fine forest tree, with a bole 60 ft. high and 8 to 9 ft. in girth, the wood of which is used by the natives for canoes and appears to be resistant to insect and fungoid attack. Mr. Lane-Poole states that attempts are being made in Raboul, New Britain, to distil the bark, with a view to exporting the oil.

The samples of bark were examined with the following results :

No. 1.—This consisted of pieces of bark, 6 to 11 in. long, 1½ to 2 in. broad, and about ⅛ in. thick. The bark had a pleasant aromatic odour.

The outer bark was greyish-brown and fairly smooth ; the inner bark was light brown, smooth and fibrous.

When submitted to steam distillation the bark yielded 6 per cent. of a pale yellow, limpid oil, having an odour of cloves and nutmeg. The oil had the following constants, which are given in comparison with those recorded for oil distilled from New Guinea " massoy " bark :

	Oil from Sample No. 1.	Oil from New Guinea " massoy " Bark.
Specific gravity at 15°/15° C.	1·060	1·04 to 1·065
Optical rotation α_D	−0·90°	—
Refractive index $n_{D20°}$ C.	1·534	—
Phenols (mainly or entirely eugenol) expressed as eugenol . . . . *per cent.*	60	70 to 75

The bark thus furnished a good yield of an essential oil which was apparently similar in character to that obtained by previous investigators from " massoy " bark from New Guinea. The quantity of oil available was not sufficient for complete investigation, but from the results of the preliminary examination the oil would appear to consist almost entirely of eugenol and safrole. This view was confirmed by the examination of the second, larger, sample of bark.

No. 2.—This sample had a pleasant aromatic odour. The material generally resembled Sample No. 1, but was darker and considerably thicker, apparently consisting of older bark.

On steam distillation the bark furnished 6·3 per cent. of a pale yellow, limpid oil, having an odour of cloves and nutmeg. The oil had the following constants :

	Oil from Sample No. 2.
Specific gravity at 15/15° C.	1·064
Optical rotation α_D	−0·34°
Refractive index $n_{D20°}$ C.	1·536
Phenols (expressed as eugenol) . *per cent.*	79

An examination of the phenolic portion of the oil showed that it consisted mainly, if not entirely, of eugenol.

After the removal of the phenolic portion, the residual oil had the following constants :

Specific gravity at 15/15° C.	1·035
Optical rotation α_D	−1·40°
Refractive index $n_{D20°}$ C.	1·522

This non-phenolic portion of the oil, on repeated fractional distillation under atmospheric pressure, furnished the following fractions :

Fraction.	Boiling at	*Per cent.*
1	175°—225° C.	25
2	225°—236° C.	68
3	236°—240° C.	5
Residue		2

Fraction No. 1 was evidently composed largely of terpenes.

Fraction No. 2 was found to consist almost entirely of safrole, and on redistillation nearly the whole of it boiled at 229°−233° C. The congealing point of this fraction was + 7° C. as compared with + 11° C. recorded for pure safrole.

The foregoing results show that the approximate composition of the volatile oil from the second sample of Massoi bark from Papua was as follows :

	Per cent.
Eugenol	79
Safrole	14
Other constituents (principally terpenes)	7

The oil obtained from the second sample of bark was submitted to importers in London, who considered that the only commercial outlet for the oil in this country would be as a source of eugenol, for which purpose it would have to compete with such products as clove, cinnamon and pimento oils. The firm were of opinion that the nominal value of the oil from this point of view would be about 4*s.* per lb. ex wharf London (April 1925), but they pointed out that it would be difficult to create a demand for it unless manufacturers could be assured of regular supplies in shipments of at least one ton at a time.

The firm suggested that the oil might be distilled in Papua and shipped to the United Kingdom in drums, and added that although this might cause the oil to become darker in colour it would not affect its value as a source of eugenol.

Essential oil distillers who were consulted also estimated the current value of the oil at about 4*s*. per lb. On this basis, the oil obtainable from a ton of bark of the quality of the present sample would be worth about £28.

It will be seen that the second sample of Massoi bark yielded about the same percentage of oil as Sample No. 1, but that the oil contained much more eugenol than the oil from the earlier sample. It would therefore appear that the amount of eugenol in Massoi bark is subject to considerable variation, depending possibly on the age of the tree, or the part of the tree from which the bark is gathered.

If oil of the quality of that distilled from the present sample of bark could be produced in Papua in large and regular quantities, it would find a market in this country at a price dependent on that ruling for eugenol.

3. OIL OF *ORIGANUM MARU* FROM CYPRUS

The oil which is the subject of this report was forwarded for examination to the Imperial Institute by the Director of Agriculture, Cyprus, in December 1924.

The sample consisted of about 2 litres of a pale brownish-yellow oil, with a pleasant, characteristic odour resembling that of the sweet marjoram oil of commerce.

The oil was examined with the following results, which are shown in comparison with the corresponding figures obtained for samples of marjoram oil forwarded to the Imperial Institute in 1908 and 1911 under the name "Sampsisha," and for a sample distilled at the Institute from the "Sampsisha" plant (see this BULLETIN, 1913, **11**, 50). The range of constants recorded for Spanish marjoram oil is also shown.

—	Present sample.	"Sampsisha" Oils forwarded in		"Sampsisha" Oil Distilled at the Imperial Institute.	Spanish Marjoram Oil.
		1 3.	1911.		
Specific gravity at 15/15° C.	0·904	0·899	0·912	0·888	0·895 to 0·910
Refractive index n_D20° C.	1·4775	—	—	—	1·4725 to 1·4775
Optical rotation α_D20° C.	+9°27′	+14°2′	+3°45′	+13°15′	+15° to +20°
Acid value	4·1	6·4	8·25	12·8	0 to 1·0
Ester value before acetylation	4·1				10 to 30
Ester value after acetylation	74·5	—	71·2	—	—
Percentage of oil absorbed by a 5 per cent. solution of caustic soda	2·5	—	—	2·0	—
Solubility in 80 per cent. alcohol at 15° C.	soluble in 1·4 vols.	soluble in 1·3 vols.	soluble in 1 vol.	—[1]	soluble in 2 vols.

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[1] *Soluble in* 8–9 *vols. when freshly distilled, and in* 1–4 *vols. after keeping for* 4 *years.*

From these results it will be seen that the constants of the present oil generally resemble those of the marjoram oils previously received at the Imperial Institute from Cyprus and of the Spanish marjoram oil of commerce.

The demand for marjoram oil in the United Kingdom is very limited, the oil being only employed to a relatively small extent for perfuming soap, and for certain culinary and toilet preparations. A firm of soap-makers who were consulted by the Imperial Institute were of opinion that this Cyprus oil could be utilised for compounding the cheaper classes of perfumes used for common toilet soaps, etc., and that it might realise a price between that of thyme terpenes and that of Spanish thyme oil, which were then selling respectively at 3*s.* to 3*s.* 6*d.* per lb. and at 5*s.* 9*d.* to 6*s.* per lb. (March 1925).

From the foregoing results it will be seen that this oil is not likely to realise a high price in the United Kingdom. It was suggested that if it is desired to produce the oil on a commercial scale, a trial consignment of about 1 cwt. should be forwarded to test the market before steps are taken to increase the production.

4. MEDANG LOSOH OIL FROM THE FEDERATED MALAY STATES

Two samples of medang losoh oil distilled in the Federated Malay States from the wood of *Cinnamomum parthenoxylon*, Meissn., have been examined recently with a view to ascertaining its commercial value. *C. parthenoxylon*, according to Ridley (*Flora of the Malay Peninsula*), is a lofty tree, 30 to 100 ft. tall, occurring in woods in hilly districts throughout Malaya. The samples received were as follows:

"*A. Original Sample.*"—A yellow oil with a pronounced odour of safrole.

"*B. Steam-distilled Sample.*"—An oil of a paler tint than sample A, but resembling it in odour.

Both oils, as received, were slightly cloudy owing to the presence of moisture. After being rendered clear by filtration, sample A was a bright yellow oil, whilst sample B was almost colourless.

The oils were found to have the following constants, which are shown in comparison with figures obtained by the Agricultural Chemist, Federated Malay States and Straits Settlements (in a MS. report furnished to the Imperial Institute), and by the Agricultural Department at Buitenzorg, Java (*Jaarb. Dep. Landb. in Ned.-Indië*, 1909, p. 64; 1910, p. 49).

—	Present samples.		Results obtained in	
	A.	B.	Malaya.	Java.
Specific gravity at 15°/15° C.	1·103	1·103	1·1012	1·067 and 1·080
Optical rotation α_D	nil	nil	nil	+ 1°22′ and + 1°3′
Refractive index $n_D 20°$	1·538	1·538	1·538	1·532
Ester value before acetylation	0·8	—	—	—
Ester value after acetylation	3·5	—	—	11.8
Congealing point	+10°C.	+10·5°C.	—	—
Solubility in 90 per cent. alcohol at 15° C.	Soluble in 3·5 vols.	—	—	—

On distilling sample A under 772 mm. pressure, the following fractions were obtained:

Fraction boiling at	*Per cent.*
234° to 237° C.	91
237° to 239° C.	5
Residue	4

The foregoing results confirm those previously obtained in Malaya and Java and show that medang losoh oil consists principally of safrole. Pure safrole has a specific gravity of approximately 1·1 at 15°/15° C., refractive index 1·540, congealing point 11° C., and boiling point 233° C.

The oil was submitted to a firm of soap manufacturers for an opinion as to whether it could be used in place of safrole for perfuming soap. They considered, however, that the odour of the oil would not be so much appreciated as that of safrole itself, and that consequently the oil would be less satisfactory for the purpose. In their opinion, it is doubtful whether more than 1*s.* 3*d.* per lb. would be obtainable for the oil in competition with safrole, which is at present realising 1*s.* 6*d.* per lb. in the United Kingdom (October 1925).

Supplies of medang losoh oil might find a market as a cheap perfume for soap, but it appears unlikely that the oil would realise as high a price as pure safrole for this purpose. It was suggested that if a price of 1*s.* 3*d.* per lb. is likely to be remunerative, a small consignment of the oil might be forwarded to the Imperial Institute for sale, in order to test the market.

DUGONG OIL FROM AUSTRALIA

THE dugongs are herbivorous aquatic mammals frequenting the shallow waters of tropical seas, from East Africa to Australia. The Australian dugong (*Halicore australis*), which sometimes attains a length of 15 ft., occurs along the coast from Moreton Bay to Cape York. Considerable numbers are caught in nets by the natives, who eat the flesh, whilst the oil from the blubber has been used in Australia as a substitute for cod-liver oil. A full-grown dugong is said to yield from 10 to 12 gallons of oil.

A sample of dugong oil was forwarded for examination to the Imperial Institute in March 1925, from the office of the High Commissioner for Australia. It consisted of a cream-coloured, semi-solid oil, with a very slight taste and odour free from any fishy character.

The filtered oil was examined with the following results, which are shown in comparison wit [illegible] nge o[illegible] corresponding figures previously recorded for dugong [illegible] by various investigators :

		Present sample.	Results previously recorded
Specific gravity at 15°/15° C.		0·9242	0·9[illegible] to [illegible]203
Specific gravity at 100°/15° C.		0·8622	
Refractive index at 40° C.		1·458	1·459 to [illegible]·60
Optical rotation in a 200 mm. tube at 40° C.		−0·12°	−0·[illegible]° to −0·21°
Solidifying point of fatty acids		34·6° C.	33° C.
Acid value		0·3	0·31 to 5
Saponification value		204·7	197·5 to 200·3
Iodine value (Hübl. 17 hours)	*per cent.*	52·3	64·26 to 6[illegible]·6
Unsaponifiable matter	,,	0·2	0·01 to 3·7[illegible]
Volatile acids, soluble		0·3[1]	5·0[1]
Volatile acids, insoluble		1·6[1]	—

[1] *Cubic centimetres of decinormal alkali required to neutralise acid from 5 grams of oil.*

It will be seen that the constants of the present sample are in general agreement with those previously obtained for dugong oil, but that the saponification value is slightly higher and the iodine value lower than the recorded figures.

Dugong oil does not appear to have been produced hitherto on any large scale and it rarely appears on the markets of the United Kingdom.

It seems doubtful whether it would be worth while to take active steps to create a demand for it in this country unless it could be obtained in sufficient quantities and at such a price as to allow of its commercial utilisation for soap-making or possibly for the manufacture of edible fats. It is probable that small quantities could be disposed of in Australia as a substitute for cod-liver oil as it has been stated in the Commonwealth that the oil is at least equal to cod-liver oil in medicinal value and has the advantage of greater palatability.

It was suggested to the Australian authorities that if it is considered that there is any prospect of large supplies of dugong oil becoming available, information should be forwarded as to the quantities which could be shipped, and the lowest price at which the production and export of the oil would be profitable. The Imperial Institute would then be glad to make further enquiries regarding the possibilities of the disposal of shipments in this country.

ARTICLE

CEMENT MANUFACTURE AND ITS POSSIBILITIES IN THE CROWN COLONIES AND PROTECTORATES

PART IV

In the first two parts of this article (this BULLETIN, 1924, **22**, 173; 433), the cement-making possibilities of the British Crown Colonies and Protectorates in Africa were considered. Part III (this BULLETIN, 1925, **23**, 32) dealt with the British West Indies and the island Colonies and Protectorates of the Pacific, and the present part treats of the cement resources of the Asiatic Colonies and Protectorates of British Malaya, North Borneo, Sarawak, Ceylon and Hong Kong, and also of Palestine, Cyprus and Malta.

Attention may here be drawn to the recent revision which has been made in the British Standard Specification for Portland cement and its consequent bearing on the composition of the raw materials used (see p. 472).

BRITISH MALAYA

Very considerable quantities of Portland cement are used annually in Malaya, but so far the amount produced locally has been small and quite inadequate to meet requirements. The only cement factory now in operation is a small one, in Selangor; a larger factory which was erected some few years ago near Singapore has now been closed.

Statistics regarding the consumption of cement in Malaya are given in the following tables (in which the trade between the various ports of British Malaya is disregarded):

Imports of Portland Cement

(Casks of 400 lb.)

Into	1921.	1922.	1923.	1924.
Straits Settlements [1] . . .	369,938	312,473	436,538	—
Federated Malay States [2] . .	78,284	34,052	75,265	—
Non-Federated Malay States [3] .	4,048	6,626	3,650	—
Total . . .	452,270	353,151	515,453	518,000[4]

(*For footnotes, see next page.*)

Re-Exports of Portland Cement

(Casks of 400 lb.)

From				
Straits Settlements[1] . . .	23,384	39,627	25,426	—
Federated Malay States[2] . .	2	4	2	—
Non-Federated Malay States[3] .	—	9	—	—
Total . .	23,386	39,640	25,428	30,420[4]

[1] *Comprising Singapore, Penang, Malacca, Labuan, Christmas Island and the Dindings.*

[2] *Comprising Perak, Selangor, Negri Sembilan and Pahang.*

[3] *Comprising Johore, Kedah, Perlis, Kelantan and Trengganu.*

[4] *Estimated.*

Federated Malay States.—The occurrence of limestone has been recorded by the Government Geologist in many localities in the Federated Malay States, but in most cases the material is dolomitic and hence unsuitable for use in making Portland cement.

Since 1912, a small cement factory, known as the Batu Caves Cement Works, has been in operation in Selangor. The following information regarding the factory has been kindly supplied by Mr. E. J. Read.

From 1915 to 1920 the output of cement from this factory averaged about 5,000 tons per annum, but the production for the years 1921, 1922 and 1923 was only 1,768, 490 and 1,173 tons respectively. The greatest output was in 1915 when 5,725 tons were produced.

The steep cliffs from which the Batu Caves Cement Works draws its raw material consist principally of a blue magnesian limestone. Occasionally among this material occur patches of good white crystalline limestone, but the quantity of magnesia in this varies considerably. Analyses of two samples of selected limestone, made some years ago, were as follows :

		1. *Per cent.*	2. *Per cent.*
Lime	CaO	55·00	51·40
Magnesia	MgO	0·29	3·13
Alumina	Al_2O_3 . .	0·40	0·26
Ferric oxide	Fe_2O_3 . . .		
Silica	SiO_2	0·44	0·60
Loss on ignition	. . . .	43·62	43·50

When the factory was first started the necessary clay was obtained from Port Swettenham. This was a very plastic mud, the composition of which varied between the following percentage limits :—silica, 57·9 to 64·7 ; ferric oxide and alumina, 16·3 to 21·2. The material proved somewhat difficult to handle and subsequently a red clay found near the limestone deposit was used. This clay varied in composition between the following percentage limits :—silica, 52·8 to 53·8 ; iron oxide and alumina, 30·3 to 33·6. The fuel used at the commencement of operations was imported anthracite, but it is understood that more recently coal from the Rawang Colliery has been employed.

As regards other areas, crystalline limestone forms the rugged floor of the valleys in the Kinta district of Perak, and occasionally rises in the form of hills. According to the Government Geologist, a sample of Kinta limestone from near Menglembu contained 54·5 per cent. of lime and 1·3 per cent. of magnesia. Such limestone would be suitable for use in making Portland cement, but it apparently reaches the surface in only a few localities.

On the Perlis border, rugged limestone hills occur in which tin is worked.

Straits Settlements.—To supply the large demand for cement in the Straits Settlements, a factory was erected on the island of Singapore in 1920. Owing to the high cost of the raw materials the works only ran for a short time and are now closed. Most of the northern and central part of the island is composed of granites and similar rock and the products resulting from their weathering. The calcium carbonate required by the works was, therefore, obtained from the Pulau Damar coral reef, which lies near the coast about five miles south of the cement works, and adjacent to Pasir Panjang. For many years past this reef has been worked at low water by natives, who sell the coral to local lime-burners or to contractors for building purposes.

The clay used for incorporation with the coral was blue-grey estuarine mud obtained from land adjoining the works site, about nine miles from the town of Singapore, on the west coast road at the mouth of the Tandan river. Gypsum was not available locally in sufficient amount and had to be imported. Fuel had to be imported either from the Rawang Collieries of the Federated Malay States or the Dutch concessions at Sofeko.

The "wet" process of manufacture was employed. The plant, which included two rotary kilns, each 125 ft. long, was designed to obviate manual labour so far as possible, and is stated to have cost £250,000. It was designed for an output of 1,500 casks of cement per day, but at the start a production of only 600 casks per day was attempted.

A sample of the cement made at the Singapore works was examined at the Imperial Institute with the following results:

Chemical Analysis:		*Per cent.*
Silica	SiO_2	21·96
Insoluble residue		0·57
Ferric oxide	Fe_2O_3	1·79
Alumina	Al_2O_3	7·15
Lime	CaO	62·85
Magnesia	MgO	1·26
Total sulphur as	SO_3	1·38
Loss on ignition		2·22
Fineness:		
Residue on sieve 180 × 180		13·8 *per cent.*
Residue on sieve 76 × 76		0·3 *per cent.*
Setting time:		
Initial		15 *minutes*
Final		3 *hours* 23 *minutes*
Tensile strength:		
Of neat cement at 7 days		704 *lb. per sq. in.*
Of cement-sand at 7 days		272 *lb. per sq. in.*

NORTH BORNEO

The quantity of cement at present consumed in North Borneo is small, but the possibility of producing Portland cement locally has recently received attention.

According to information supplied to the Imperial Institute by the British North Borneo Co., frequent outcrops of limestone are to be observed from Sukau, some 20 miles from the mouth of the River Kinabatangan, as far as Bulangan, a further 25 miles (both scaled cross-country mileages). Near Sukau on the south bank of the river the outcrop forms a hill about 120 feet high and has a depth of nearly half a mile; and at Bulangan there is another outcrop 200 feet high and running for about two miles in a northerly direction. Only a superficial examination has been made of these and the intervening small hills and outcrops, but there is every reason to anticipate that a very extensive area of limestone could be quarried and transported with ease to the river. The face of the hills on the river side and the existence of limestone caves further inland all tend to confirm this opinion.

Specimens of limestone, clay and silt were forwarded to the Imperial Institute in 1924 by The British North Borneo Company, in order that their suitability for use in the manufacture of Portland cement might be ascertained by analysis and technical trials.

The limestones received were as follows :

Samples " S1 " and " S2 " were from Sukau and consisted of cream-coloured fossiliferous limestones.

Sample " D " was obtained from Bilit and consisted of a greyish limestone conglomerate with some patches of cream-coloured material.

Sample " E " was a dark grey limestone conglomerate from Bulangan.

Duplicate samples of these limestones, forwarded at a later date, were similar in appearance to the corresponding samples first received. Three further samples, S1A, S1B, S1C, from other parts of the Sukau deposit were also supplied.

Chemical analyses were made of representative portions of the four samples included in the first consignment and also of five samples from the second consignment. The results obtained were as follows :

Limestones.

		First Consignment.				Second Consignment.				
		S1	S2	D	E	S1A	S1B	S1C	D	E
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO .	54·37	53·78	52·33	50·99	51·75	52·82	52·47	49·64	48·62
Magnesia	MgO .	0·88	1·28	1·79	2·43	1·41	1·57	1·69	2·46	3·82
Alumina	Al_2O_3 .	0·41	0·11	0·70	0·55	0·90	0·59	0·48	1·67	0·98
Ferric oxide	Fe_2O_3 .	0·22	0·32	0·35	0·58	0·24	0·19	0·19	0·44	0·49
Sulphuric anhydride	SO_3 .	0·04	0·16	0·19	0·23	Not determined.				
Phosphoric anhydride	P_2O_5 .	trace	trace	nil	0·03					
Silica	SiO_2 .	0·51	0·85	1·60	2·64	3·09	1·75	1·97	3·18	4·47
Loss on ignition	. .	43·50	43·31	42·95	42·52	42·10	42·71	42·69	41·57	41·17

The above analyses show that, as regards chemical composition, limestones represented by samples S S2 and D of the first consignment, and S1A, S1B and S1C of the second consignment, would be suitable for the manufacture of Portland cement conforming to the requirements of the British Standard Specification. The amount of magnesia present in samples D and E of the second consignment and probably E of the first consignment is too high for this purpose, but all three could be used for the manufacture of cement conforming to the requirements of the United States or German specifications.

The samples from different points in the Sukau No. 1 deposit, viz. S1A, S1B and S1C, show gradations in composition, the material taken from a point nearest the river level (S1C), containing the largest amount of magnesia.

The clays received were as follows :

" Bilit Estate No. 1."—A plastic buff-coloured clay mottled with iron stains and containing practically no coarse sand.

" Bilit Estate No. 2. Blue Clay."—A plastic clay very similar in appearance to No. 1, but rather more siliceous.

" Batu Puteh No. 3. Blue and White Clay."—A mottled clay, fairly plastic and free from coarse sand.

" Batu Puteh No. 4. Blue Clay."—A plastic greyish-brown clay containing a fair proportion of fine sand.

" Silt from Sukau."—A greyish-brown clay containing a fair quantity of fine sand.

The following table shows the results of the chemical analysis of five of the samples :

		Bilit White Clay No. 1.	Bilit Blue Clay No. 2.	Batu Puteh White and Blue Clay No. 3.	Batu Puteh Blue Clay No. 4.	Sukau Silt.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	66·67	73·69	63·89	62·20	72·62
Alumina	Al_2O_3	15·66	11·22	16·50	18·98	10·22
Ferric oxide	Fe_2O_3	4·45	4·53	4·36	3·48	4·29
Lime	CaO	0·38	0·76	0·31	0·32	0·70
Magnesia	MgO	1·57	1·17	1·47	1·25	1·48
Phosphoric anhydride	P_2O_5	0·08	trace	0·04	0·05	0·02
Potash	K_2O	*	*	1·76	1·62	*
Soda	Na_2O	*	*	0·82	1·42	*
Loss on ignition		8·59	6·44	10·55	10·23	8·78

* *Not determined.*

The examination of the clays showed that as regards physical and chemical composition samples Nos. 1, 3 and 4 could be used in the manufacture of Portland cement, but that the percentage of silica is too high in sample No. 2 and in the Sukau silt. It is possible that these latter materials, if submitted to a suitable washing process, might give a product sufficiently low in silica. It is not suggested, however, that this treatment should be adopted, as suitable clays are otherwise available.

Cement Burning Trials.—As there was considerable similarity between certain of the clays and also between certain of the limestones it was not considered necessary to carry out trials with all those materials whose chemical composition appeared satisfactory. The materials with which burning trials were carried out were as follows :

No. 1, Limestone S1 with clay No. 1.
No. 2, „ D „ No. 1.
No. 3, „ E „ No. 4.

The limestones used in the trials were, in all cases, those received in the first consignment. Each of the three limestones was fairly soft and easily reducible in the grinding mill.

In the clays used in the experimental burnings, the chemical constituents are well proportioned ; the sand was in a very finely divided condition, practically all of it passing a sieve having 100 meshes per linear inch.

The details of the individual trials were as follows :

Mixture No. 1 was composed of 3·43 parts by weight of the Sukau limestone No. 1 to 1 part of Bilit clay No. 1. It was ground until only 12·3 per cent. failed to pass a sieve having 180 meshes per linear inch. After burning, the clinkered material was ground in a ball mill, and 2 per cent. of finely ground plaster of Paris added to adjust the setting time.

Mixture No. 2 was composed of 3·7 parts by weight of Bilit limestone D to 1 part of clay No. 1 from Bilit, and was ground until only 9·4 per cent. was left on a sieve having 180 meshes per linear inch. It was burnt at a slightly lower temperature than mixture No. 1 on account of the lower percentage of lime which it contained. The setting time of the cement was adjusted [illegible] addition of 2 per cent. of plaster of Paris as with Mixture No

Mixture No. 3 was composed of 4 parts by weight of Bulangan limestone E to one of clay No. 4 from Batu Puteh, the final grinding of the mixture being continued until a residue of only 15 per cent. was left on a sieve having 180 meshes per linear inch.

The higher percentage of magnesia in this mixture tends to lower slightly the point at which softening occurs during burning, and attention would need to be given to this matter when working commercially in order to avoid the possible formation of "rings" in the kiln.

The following results were obtained on testing the finished cements :

Chemical Composition.

		Mixture 1. *Per cent.*	Mixture 2. *Per cent.*	Mixture 3. *Per cent.*
Silica	SiO_2	22·88	23·42	22·27
Insoluble matter		0·12	0·02	0·23
Alumina	Al_2O_3	6·00	5·54	7·28
Ferric oxide	Fe_2O_3	2·08	2·62	2·00
Lime	CaO	64·94	63·63	63·23
Magnesia	MgO	1·90	2·84	3·50
Sulphuric anhydride	SO_3	1·31	1·26	1·22
Loss on ignition		0·52	1·20	0·30

The physical tests resulted as follows :

	Cement Produced from Mixture No. 1.	No. 2.	No. 3.
Fineness :			
Residue on 76 mesh sieve, *per cent.*	0·1	trace	trace
Residue on 180 mesh sieve, *per cent.*	9·4	6·8	8·4
Setting time :			
Initial, minutes . . .	40	30	184
Final, minutes . . .	76	99	258
Soundness :			
Expansion by the Chatelier test, mm. . . .	0·5	0·5	1·0
Tensile strength :			
Neat cement at 7 days, *lb. per sq. in.*	1,023	890	917
Neat cement at 28 days, *lb. per sq. in.*	1,069	1,047	1,002
Cement-sand at 7 days, *lb. per sq. in.*	457	428	397
Cement-sand at 28 days, *lb. per sq. in.*	499	506	424

The above results of the analysis and mechanical tests of the cements yielded by mixtures Nos. 1, 2 and 3 show that they are perfectly sound, of the highest quality and strength, and comply in every respect with the requirements of the British Standard Specification for Portland cement. If desired, a reduction in the percentage of lime could be effected by a suitable adjustment of the proportions of limestone and clay in the mixture.

In considering the above analyses of the cements made at the Imperial Institute, it should be recognised that they represent pure clinker uncontaminated with fuel ash. Such contamination, which always occurs under commercial conditions when solid fuel is used, would increase slightly the percentages of silica, alumina and ferric oxide in the cement, and proportionately lower the amount of lime.

From a consideration of the above it is evident that large reserves of limestones and clay suitable for making high-grade Portland cement are available in North Borneo. The extensive coal resources of the country would furnish fuel suitable both for power purposes and for burning the cement in the kiln.

SARAWAK

The consumption of Portland cement in this State is at present small.

The following notes on the occurrence of limestones and clays which might be suitable for the local manufacture of cement were recently transmitted to the Imperial Institute by the Secretary to the Sarawak State Advisory Council, who stated that the technical information had been supplied by the Superintendent of Lands and Surveys, and the Commissioner of Public Works.

So far as is known, no steps have yet been taken to manufacture cement in Sarawak. There is no doubt, however, that all the materials necessary for its production occur in Sarawak, within reasonable distance of each other, and could be easily transported.

Limestone is burnt for lime at Bau, and sea-shells are used for the same purpose at Bako and Kuala Tebas. None of the products obtained are hydraulic limes.

Patches of whitish clay, which appears to contain silica in a very finely divided condition, are exposed on the river bank at many places between Kuching and the mouth of the river. Similar exposures are to be found in the Batang Kupar at Sembauh and in Saribas, below the Paku, near Bungin.

The river mud at Kuching, used by the local brass founders for mouldings, has the appearance of being suitable for cement-making.

Sadong coal which might be used as fuel is rather short-flaming and probably contains more ash than is desirable for cement manufacture.

In Upper Sarawak there occur enormous quantities of limestone which present no difficulties in quarrying. In places these limestones carry more silica than would be desirable for the manufacture of cement, but in other localities the rock is very pure.

There is no shortage of clays in that district, but it is likely that they would contain far too much silica for cement-making purposes, as they are, for the most part, the decomposition products of very highly metamorphosed shales and slates.

No deposits of limestone or other calcareous material have been observed in the Third Division, but limestone occurs at Nish in the Fourth Division.

If a serious attempt to establish a cement industry in the country were contemplated, it might be feasible to bring limestone and coal down the Sadong and use estuarine mud as the argillaceous material. Transport charges on the raw materials would thus not be heavy and admirable facilities would be available for the shipping of the finished product.

CEYLON

The quantities of cement imported into Ceylon for commercial and for Government purposes during the years 1919–1924 are given below:

	Commercial.	For Government Stores.
	Tons.	*Tons.*
1919	7,606	7,421
1920	17,680	4,634
1921	9,659	9,082
1922	23,016	Not recorded.
1923	26,066	2,960
1924	28,235	7,506

A duty of 30 cents per cwt. is imposed on imported cement.

The whole of the cement imported is used in the Island. It appears probable that the consumption of Portland cement will increase, and in any case the quantity now imported is sufficient to justify the erection of modern plant for its manufacture, provided that the requisite raw materials are economically available. It might be possible also to export part of the output to India, but here it would have to compete with both imported cement and that made at the several Indian factories now in operation.

The possibility of making cement in the Island has received considerable attention from the Principal Mineral Surveyor in Ceylon, and also from several firms, and a large number of samples of likely raw materials have been submitted to the Imperial Institute for analysis and technical trial. A special report on the cement-making resources of Ceylon, supplied to the Institute by the Principal Mineral Surveyor, has been incorporated in the following statement.

For convenience of treatment the subject will be dealt with under four categories, (1) Crystalline Limestones, (2) Estuarine Limestones of Jaffna, (3) Coral Deposits on the West Coast, and (4) Coral Deposits on the East Coast.

1. *Crystalline Limestones*

Crystalline limestones occur throughout the Island, the exposures being most numerous in the northern part of the hill country and on its south-eastern flank. The chief occurrences of such limestone are found from Kandy eastwards to Hanguranketa and north of this line, through Matale and Nalande as far as Habarane. The bands of limestone are comparatively narrow at the southern end of the belt, but to the north greater widths are shown, e.g. at Sigiriya where the outcrop measures one mile across. Another prominent group of limestone bands extends from near Koslande to Badulla.

A number of samples of crystalline limestone from various localities in Ceylon have been submitted to chemical analysis, and some typical results are shown in the following table. The analyses of Nos. 1 and 2 were made at the Imperial Institute and of Nos. 3 and 4 by the Agricultural Chemist, Colombo.

		No. 1. Kadikawa (North Central Province).	No. 2. Diyaluma-Koslande (Uva Province).	No. 3. Matale district (Central Province).	No. 4. Kandapola (Central Province).
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	45·61	30·41	39·0	36·0
Magnesia	MgO	8·50	20·98	0·3	26·3
Alumina Ferric oxide	Al_2O_3 Fe_2O_3	1·56	0·70	4·0	2·0
Silica	SiO_2	0·17	3·20	26·1	4·1
Loss on ignition		44·70	43·54	—	—

It appears from the above and other analyses that most of the crystalline limestones of the interior of Ceylon are highly dolomitic and unsuitable for use in cement-making.

2. *Estuarine Limestones of Jaffna*

The most promising sources of calcium carbonate for cement-making are the massive estuarine limestones of the Jaffna peninsula, which occur in an easily accessible region in proximity to clay beds.

The Jaffna peninsula is a slightly elevated plateau of recent marine massive limestone. The exposures of the rock cover an area of over 100 square miles, in nearly horizontal beds, to a maximum observed thickness of 50 feet. Intercalations of sandy limestone occur, but they are infrequent and of small extent. There would be no difficulty in quarrying high-grade limestone on a large scale in several localities.

At the west end of the peninsula a gradual transition can be observed from loose coral rubble to massive limestone. An extension of the Jaffna limestone can be traced southwards along the west coast, eventually giving place to an alternation of sandy and clayey beds with impure limestones. The whole series dies out in the neighbourhood of Puttalam.

Clay-beds yielding material suitable for cement-manufacture occupy hollows in the limestone plateau and cover large areas of the lower ground. The individual beds are generally of limited extent and thickness, but enough material could be found without difficulty for work on a small manufacturing scale.

The whole district was examined by the Mineral

Survey, and an area chosen for more detailed examination near Kankesanturai, as the most conveniently situated locality. Analyses made at the Imperial Institute of samples of limestones gave the following results :

		No. 199. *Per cent.*	No. 200. *Per cent.*	No. 201. *Per cent.*	No. 202. *Per cent.*	No. 203. *Per cent.*	No. 204. *Per cent.*
Lime	CaO	54·35	54·61	53·72	39·87	54·81	53·55
Magnesia	MgO	0·38	0·48	0·56	0·77	0·28	0·66
Alumina	Al_2O_3	0·47	0·36	0·69	4·67	0·61	1·05
Ferric oxide	Fe_2O_3	0·17	0·10	0·21	1·13	0·12	0·12
Silica	SiO_2	0·68	0·26	1·08	19·32	0·62	1·28
Soda	Na_2O	*	*	*	0·54	*	*
Potash	K_2O	*	*	*	0·96	*	*
Titanium dioxide	TiO_2	*	*	*	0·43	*	*
Loss on ignition		43·55	43·92	43·32	32·85	43·46	43·1

* *Not determined.*

The average composition of the above samples, excluding No. 202, is as follows :

		Per cent.
Lime	CaO	54·21[1]
Silica	SiO_2	0·78
Alumina	Al_2O_3	0·64
Ferric oxide	Fe_2O_3	0·15
Magnesia	MgO	0·47
Loss on ignition		43·47

Corresponding to about 96 per cent. of calcium carbonate.

Sample No. 202, which was taken from the bottom of the cliff at Kirimalai, contains an excess of alumina and silica. The other limestones are nearly pure and eminently suitable for cement manufacture.

In 1920 a further series of eight limestones from Jaffna were analysed at the Imperial Institute, and found to be of very similar composition to the above.

The following are analyses of a number of samples of clay from Kadduvan, about one mile south-east of Kankesanturai.

		No. 208. *Per cent.*	No. 209. *Per cent.*	No. 210. *Per cent.*	No. 211. *Per cent.*	No. 212 *Per cent.*
Silica	SiO_2	52·20	51·78	49·67	53·60	50·67
Alumina	Al_2O_3	21·53	22·37	18·72	20·61	22·91
Ferric oxide	Fe_2O_3	9·70	9·39	10·59	9·55	10·16
Lime	CaO	1·02	0·70	1·38	0·58	0·72
Magnesia	MgO	0·75	0·60	1·13	0·79	0·65
Titanium dioxide	TiO_2	1·47	1·16	1·04	1·00	1·35
Manganous oxide	MnO	0·08	0·14	0·38	0·14	0·14
Soda	Na_2O	0·26	0·58	1·52	0·72	0·52
Potash	K_2O	0·40	0·48	1·20	0·50	0·36
Sulphuric anhydride	SO_3	0·04	0·08	0·17	0·09	0·17
Loss on ignition		12·74	13·20	14·68	12·30	12·60

The results of these analyses show that the clay would be quite suitable for use in the manufacture of Portland cement. All the samples contain a fairly high percentage of sand, but as a large proportion of this sand is in a fine state of division no serious difficulty in the process of manufacture need be anticipated.

Analysis No. 212 was made on a sample of clay from which the coarse sand had been removed by washing. It carries a slightly lower proportion of silica, but otherwise shows little advantage in chemical composition.

For comparison, the composition of (1) average samples of clay from Kadduvan, (2) average samples of clay from the neighbouring village of Taiyiddi, and (3) Medway mud, which is largely used in cement manufacture, are shown in the table below :

		No. 1. Kadduvan Clays.[1] *Per cent.*	No. 2. Taiyiddi Clays. *Per cent.*	No. 3. Medway Mud. *Per cent.*
Silica	SiO_2	51·81	53·3	54·80
Alumina	Al_2O_3	20·81	21·9	14·40
Ferric oxide	Fe_2O_3	9·81	8·3	8·10
Lime	CaO	0·92	0·9	2·97
Magnesia	MgO	0·82	0·8	1·63
Titanium dioxide	TiO_2	1·17	0·9	—
Manganous oxide	MnO	0·18	—	—
Potash	K_2O	0·62	—	0·75
Soda	Na_2O	0·77		
Sulphuric anhydride	SO_3	0·09	—	1·69
Loss on ignition		13·23	—	15·29

[1] *Analysis made at the Imperial Institute.*

The possibility of employing lagoon mud from the Jaffna district in place of clay has received some attention, and six samples were submitted to the Imperial Institute for examination in 1920.

All the muds were calcareous, but with one exception they contained too much coarse sand to permit of their being economically employed in making Portland cement. The mud, the physical condition of which was considered suitable for the purpose, was found on analysis to contain too little alumina.

It may be convenient here to consider the requirements of a works to manufacture 25,000 tons of cement annually from the raw materials of Jaffna. Taking the proportion of limestone to clay in the raw mixture as 3 to 1, and estimating that 30 cwts. of mixture are required to yield one ton of cement, there would be required for 25,000 tons of finished cement about 28,100 tons of limestone and 9,400 tons of clay.

There should be no difficulty in quarrying the limestone on the plateau near Kankesanturai to a depth of 15 feet, and the clay to about 9 feet. An acre of ground quarried to these depths would yield limestone 48,400 tons, clay 21,780 tons, and the annual requirements of the factory would, therefore, be limestone ground 0·58 acres, clay ground 0·43 acres. Estimating for a life of the works of 50 years, it would be necessary to secure 29 acres of limestone ground and 21·5 acres of clay ground. Several tracts of both limestone and clay ground occur quite near to Kankesanturai, and these would suffice for a much larger output or a longer life.

There would be difficulty in negotiating the purchase of large compact areas of clay lands as there are no Crown lands suitably situated which could be utilised, and the available lands are split up for cultivation into small blocks with numerous co-owners.

As the limestone outcrops on the surface over large areas in several places, there would be practically no overburden to remove. If the quarry site were chosen near the coast or the lagoons, seepage water could be drained off, if not required for the boilers. Near the surface the limestone has the appearance of a bed of rounded nodules, closely packed and embedded in red clay and calcareous material. This is evidently the result of incomplete solution of a rock of varying compactness and solubility. At a depth of 5 to 10 feet, this passes into compact rock, which often has the appearance and fracture of chert. The compact rock should be easy to quarry, but in common with the nodules it appears to be of more than average hardness, and hence would probably be somewhat difficult to crush.

The clay beds are covered by a foot or two of sandy soil and are generally found to carry no water.

There are no known sources of gypsum in Ceylon, but the mineral could be procured from India, either from the

Salt Range in the Punjab or from the Trichinopoly district, where supplies are reported to exist.

Firewood for the boilers could be procured, if required, from the mainland, but since it would be necessary to import oil or coal for firing the kilns, it would probably be more economical to use imported fuel throughout the cement works.

There are no running streams in the district and no springs of importance, but water is procurable from shallow wells anywhere on the limestone plateau. The yield of typical wells is stated by the Provincial Engineer, Jaffna, to be on the average 300 gallons per hour.

Probably sufficient water for boiler-feeding would be obtained in quarrying the limestone.

As regards transport of stores to the works and of the finished cement to centres of consumption, the Northern Railway from Colombo crosses the peninsula from Jaffna to Kankesanturai, and passes near some of the barren limestone tracts mentioned above. Kankesanturai is 256 miles from Colombo. There is also communication with Colombo and other ports by sailing ships or coasting steamers. There is an anchorage at Kankesanturai, where sailing ships discharge cargo by means of lighters to a jetty. The water is shallow inshore, but a depth of 20 feet is reached within a quarter of a mile. During the heavy weather of the north-east monsoon when the Kankesanturai anchorage cannot be used, vessels call at Kayts, about 15 miles from Kankesanturai, and discharge cargo by lighters to Jaffna, 12 miles by rail from Kankesanturai.

3. *Coral Deposits on the West Coast*

Deposits of loose coral detritus, overlain by a small thickness of sand and alluvium, extend along the south-west coast from Ambalangoda to Matara. Most of the area is cultivated or occupied land, divided up into innumerable small holdings, and it would be impossible to acquire on reasonable terms an area large enough for a modern cement works. At Akurala, near Ambalangoda, bordering the south coast railway, at a distance of 55 miles from Colombo, there is an area of about 120 acres of swampy waste land, where coral is dug for lime-burning. This deposit was examined by the Mineral Survey. The estimate of the amount of coarse coral available was 880,000 tons. Besides this, a large quantity of fine coral, mixed with more or less sand, could possibly be utilised. Good clay is abundant in the vicinity.

4. *Coral Deposits on the East Coast*

There are raised beaches of coral near Foul Point on the south side of Trincomalee Bay and also at Elephant Point between Trincomalee and Batticaloa. Good clay can be found in both localities. These areas have not been closely examined. It is possible that cement manufacture might be undertaken at Trincomalee, but the other locality is unfavourably situated for the importation of fuel.

In 1918 a sample of coral from Trincomalee was forwarded by the Principal Mineral Surveyor to the Imperial Institute for examination. It consisted mainly of fragments of stick coral up to 1 inch in length, together with occasional pieces of plant remains, shells of mollusca and foraminifera, and a few sand grains.

The material was analysed with the following results:

		Per cent.
Lime	CaO	51·88
Magnesia	MgO	0·64
Ferric oxide	Fe_2O_3	0·67
Alumina	Al_2O_3	
Titanium dioxide	TiO_2	
Silica	SiO_2	0·76
Phosphoric anhydride	P_2O_5	trace
Loss on ignition		44·06

The above analysis shows that the coral would be suitable for use in the manufacture of Portland cement.

It is evident from the above that there exist in Ceylon, within easy reach of transport, large reserves of raw materials (excluding fuel), suitable for making Portland cement.

HONG KONG

The trade of Hong Kong in cement during recent years is indicated by the following figures:

	Imports.		Exports.	
	Quantity. *Tons.*	Value. £	Quantity. *Tons.*	Value. £
1919	11,574	62,366	64,225	440,043
1920	10,735	70,581	102,578	802,359
1921	8,095	38,393	88,712	474,766
1922	11,322	44,651	89,712	387,607
1923	24,887	85,069	66,006	222,494
1924	55,086	178,513	55,874	181,859

The cement exported, which goes chiefly to North and South China, Malaya and French Indo-China, largely exceeds the amount imported, and this is accounted for by the fact that two cement factories are in operation in the Colony at Deep Water Bay, Hong Kong, and Hok-Un, in Kowloon.

The island of Hong Kong is composed largely of igneous and plutonic rocks, and it is understood that the limestone for cement-making has to be obtained from Tonkin.

PALESTINE

The demand for cement has been steadily growing since the British occupation of the country, and especially since the Civil Administration was set up in 1921. The imports have been as follows :

	Tons.
1921	15,782
1922	31,876
1923	29,362
1924	38,256

The quantities imported during the first 9 months of 1925 amounted probably to over 40,000 tons.

The mountains of Judea and Samaria and the Carmel consist of limestone, which varies in quality and appearance. The soft white variety yields a good fat building lime. The grey and yellowish dolomitic limestone is interstratified with bands of soft marl.

While only quite small quantities of cement were used for structural purposes during the years 1921–1923, increasing quantities have been used since 1924. Monolite buildings are now being erected all over the country, especially in the new Jewish villages in the Valley of Ezdraelon. This growing demand, and the prospects of a still heavier demand in the near future, have led to the erection of a modern factory for the manufacture of Portland cement. This is situated about 4 miles to the east of Haifa, on the Haifa-Samakh railway and on the high road running from Haifa to Tiberias through Nazareth. A sum of over £300,000 has so far been invested. The property of the new Company, called the Portland Cement Co., " Nesher," Ltd., runs from the Mount Carmel outcrops for a considerable distance to the north. The quarries from which the limestone will be obtained for the cement are situated near the factory, and the clay pits are also in the vicinity. The transport of the material to the plant will, therefore, not involve undue expenditure. The limestone contains from 80 to 90 per cent. of calcium carbonate with only traces of magnesia. The clay is of a plastic nature and contains from 20 to 30 per cent. of calcium carbonate. The cement will be burnt in vertical kilns, having automatic feeding arrangements and revolving grates. The plant will produce about 250 tons of cement daily, and its power station will generate over 3,000 K.W. The works are being built in such a manner that further extension would be possible if considered advisable.

The local limestone finds another important application by the Palestine Silicate Co., Ltd., of Tel-Aviv, which was founded about 4 years ago. This undertaking manufactures white building bricks by combining lime with seashore sand. An attempt is now being made to utilise clay in the vicinity of Haifa, where a company styled the Kishon Clay Works, Ltd., recently started operations.

It is hoped that the extensive deposits of limestone and clay found all over the country will provide raw material for a variety of industries in the near future.

Much of the foregoing information was kindly supplied by the Portland Cement Company " Nesher," Ltd., and by the Central Office of the Zionist Organisation.

CYPRUS

The quantities of Portland cement imported during recent years have been as follows :

Year.	Tons.	Year.	Tons.
1919	130	1922	1,096
1920	367	1923	1,359
1921	733	1924	2,185

It is evident that, although the consumption has been steadily increasing during the past five years, the erection of even a small modern cement plant could not be justified unless a much larger quantity of cement could be used locally or exported.

A large area of the island of Cyprus consists of white chalk and chalk marls of the Kythrean series, with shelly coralline limestones above and grey and green marls below. In some places the white chalk and limestone are burnt for lime.

According to Bellamy and Jukes-Browne (*The Geology of Cyprus*, 1905), the best lime is produced from the limestones of the Trypanian rocks at Kythræa, Kyrenia and Dikomo. A sample of limestone from the last-named locality gave the following results on analysis :

		Per cent.
Lime	CaO	51·67
Magnesia	MgO	2·21
Alumina Ferric oxide	Al_2O_3 Fe_2O_3	2·50
Silica	SiO_2	0·41
Carbon dioxide	CO_2	43·04
Moisture	H_2O	0·15

Such material could be used for the production of Portland cement if used in conjunction with a suitable clay.

Deposits of puzzolana (see this BULLETIN, 1924, **22**, 184) are known to occur in the southern mountains. According to Bellamy and Jukes-Browne (*loc. cit.*), a specimen of the material from the neighbourhood of Krysovrysis had the following composition :

		Per cent.
Silica (soluble)	SiO_2	11·00
Silica (insoluble)	SiO_2	55·50
Alumina Ferric oxide	Al_2O_3 Fe_2O_3	21·34
Calcium carbonate	$CaCO_3$	5·45
Magnesium carbonate	$MgCO_3$	4·10
Moisture	H_2O	2·55

This material in conjunction with lime is stated to have found considerable local use for building purposes.

MALTA

The following table shows the quantities of cement imported into the Colony during recent years :

Year.	Tons.	Year.	Tons
1919	556	1922	2,164
1920	759	1923	3,679
1921	884		

The islands of Malta and Gozo consist largely of Tertiary calcareous sediments, including extensive deposits of coralline and globigerina limestones and some beds of greensand, marl and clay.

So far as can be ascertained, no cement is produced in the Island, although large quantities of building-lime are made.

NOTES

Reorganisation of the Imperial Institute.—The provisions of the Imperial Institute Act, 1925 (as summarised in this BULLETIN, 1925, **23**, 195), in respect of the transfer of the Institute to the control of the Department of Overseas Trade, the appointment of a Board of Governors to conduct its management under the responsible Minister, and the amalgamation with the Institute of the Imperial Mineral Resources Bureau, have been carried into effect as from July 1, 1925. On that date also the Parliamentary Secretary to the Department of Overseas Trade, as the responsible Minister, appointed Sir Richard Redmayne, K.C.B., the Chairman of the Governors of the Imperial Mineral Resources Bureau, as Director of the Institute temporarily, Sir Richard lending his services for a period not exceeding six months with a view to supervising the amalgamation of the two bodies and to advising upon the reorganisation of the combined institution.

The Board of Governors of the Institute is composed of the following members :

President : Mr. Arthur Michael Samuel, M.P., Parliamentary Secretary to the Department of Overseas Trade.

Vice-President : *Sir William Clark, K.C.S.I., C.M.G., Comptroller-General, Department of Overseas Trade.

Representatives of the Dominions and India :

The High Commissioners for :

Canada	The Hon. Peter Larkin.
Australia	The Rt. Hon. Sir Joseph Cook, G.C.M.G.
New Zealand	*Colonel the Hon. Sir James Allen, K.C.B.
South Africa	Mr. J. S. Smit.
Newfoundland	Captain Victor Gordon.
India	Sir Atul Chatterjee, K.C.I.E.

Appointed by Government Departments :

Treasury	*Mr. C. L. Stocks.
Board of Trade	Mr. P. W. L. Ashley, C.B. Dr. F. H. Hatch, O.B.E., M.I.C.E.
Colonial Office	The Rt. Hon. Lord Islington, G.C.M.G., D.S.O. *Sir Gilbert Grindle, K.C.M.G., C.B. *Mr. P. H. Ezechiel, C.M.G. (Crown Agents).
Ministry of Agriculture and Fisheries	Sir Daniel Hall, K.C.B., F.R.S.
Department of Scientific and Industrial Research	Sir Frank Heath, K.C.B.

Representatives of Scientific and Commercial Interests :

Royal Society	Professor J. B. Farmer, M.A., D.Sc., LL.D., F.R.S.
Formerly Governors of the Imperial Mineral Resources Bureau	Mr. Wallace Thorneycroft, F.R.S.E., M.I.M.E. Mr. W. Forster Brown, M.I.C.E. Mr. H. F. Marriott, A.R.S.M., M.I.C.E.
Association of British Chambers of Commerce (President)	*Mr. Stanley Machin, J.P.
Federation of British Industries	Mr. A. Johnston.
Royal Botanic Gardens, Kew (Director)	Dr. A. W. Hill, F.R.S., F.L.S.

At its first meeting the Board delegated the detailed supervision of the Institute's administration and finance to a Managing Committee of six members (whose names are indicated by an asterisk), meeting monthly under the Chairmanship of Sir William Clark, and appointed an Advisory Council on Minerals combining the Board of Governors of the late Imperial Mineral Resources Bureau with representatives of the late Advisory Technical Committee on Minerals of the Imperial Institute. Certain vacancies on the Council have still to be filled, but the present membership is as follows :

Sir Richard Redmayne, K.C.B., M.Sc., M.I.C.E., M.I.M.E., M.I.M.M., F.G.S. (Chairman),
The Rt. Hon. Lord Morris, K.C.M.G., K.C. (Vice-Chairman),
Dr. J. W. Evans, C.B.E., D.Sc., F.R.S.,
Mr. W. Forster Brown, M.I.C.E., M.I.M.E.,
Dr. F. H. Hatch, O.B.E., M.I.C.E., M.I.M.M.,
Mr. W. S. Robinson,
Mr. W. Thorneycroft, J.P., F.R.S.E., M.I.M.E.,
Professor Thomas Turner, M.Sc., F.I.C., A.R.S.M.,
Mr. H. F. Marriott, A.R.S.M., M.I.M.M., M.I.C.E.,
Sir Herbert Jackson, K.B.E., F.I.C., F.R.S.,
Sir Robert Hadfield, Bart., F.R.S.,
Admiral Sir Edmond Slade, K.C.I.E., K.C.V.O. (Vice-Chairman),
Professor J. W. Gregory, D.Sc., F.R.S.
Dr. C. Camsell.

The Board further appointed a Laboratory Committee consisting of Sir Frank Heath (Chairman), Professor J. B. Farmer, Mr. R. W. Matthew, C.M.G. (Department of Overseas Trade), and Mr. Forster Brown, and reconstituted the Advisory Technical Committees of the Institute on Silk Production and on Timbers, the Chairmen of which are Sir Frank Warner, K.B.E., and Mr. H. D. Searles-Wood, F.R.I.B.A., respectively. The operations conducted at the Institute under the direction of the London Committee of the Ceylon Rubber Research Scheme are being continued. The fifteen Advisory Technical Committees of the late Bureau dealing with different groups of minerals were reconstituted as Committees of the Institute, the members in nearly all cases agreeing to continue their services. An Advisory Council and additional Committees for raw materials of plant and animal origin are in course of formation. The former Committees for the Dominions and India have not been reconstituted, but it has been arranged that the Trade Commissioners for these countries shall have the right of attending meetings of the Advisory Technical Committees.

As a result of a comprehensive Report presented by the Director and adopted by the Board of Governors, the Institute will in future be organised in two main Sections, entitled respectively the Mineral Resources Department and the Plant and Animal Products Department, each under a Superintendent and consisting of Intelligence and Laboratory Sections. Distinct from these Departments, but serving both alike, will be the Library and Statistical Sections. The Exhibition Galleries will form a unit entirely separate from the two main Departments. A list of the Staff showing the new grouping will be published on completion of the reorganisation and the appointment of a permanent Director.

Cotton Research Station for the British Empire.—The Empire Cotton Growing Corporation, having decided to establish a Central Cotton Research Station, considered the possibilities of various parts of the Empire for the purpose. They finally concluded that Trinidad might prove to be the best locality, especially in view of its easy accessibility from England, and of the fact that the Imperial College of Tropical Agriculture has been established in the island. Another advantage of Trinidad is that, owing to the fact that no cotton is at present grown there, the Station would not encounter the difficulty which would be met with elsewhere, arising from the risk of hybridising commercial crops of cotton from varieties grown experimentally; it would also be able to control pests more easily as there would be no extensive area of cotton plants to serve as hosts.

In view of these advantages, the Corporation appointed Prof. J. B. Farmer, F.R.S., and Mr. L. G. Killby to visit the island and report on its possibilities. A summary of their report, entitled *A Cotton Research Station for the British Empire*, has now been published by the Corporation.

Attempts to cultivate cotton on commercial lines in Trinidad, which were made some twenty years ago, proved unsuccessful, owing mainly to unfavourable climatic conditions. It is considered, however, that there are several miles of country in the St. Augustine district, which are quite suitable in respect of both soil and climate, and it is recommended that the Research Station should be established in that neighbourhood. The climate is warm but humid; the mean annual temperature is about 78° F., but in the winter often falls below 70° at night. An area of 60 acres has been acquired in a belt lying immediately to the south of the northern hills, extending from St. Joseph eastwards towards Arima, where the texture and composition of the soil and the slope of the ground appear very promising for cotton-growing. Moreover, this belt occurs in the district which, as regards rainfall, is probably the best in the island.

It is recommended that instead of having a whole-time Director for the Station, a local Advisory Committee should be appointed, consisting of Dr. H. Martin Leake, Principal of the Imperial College of Tropical Agriculture, and Mr. W. Nowell, D.I.C., Assistant Director of Agriculture, Trinidad. It is suggested that the work of the Station should be primarily directed to cotton genetics and physiology; this would form a nucleus from which other activities would grow. A chief genetics investigator and a plant physiologist, each with at least one first-rate scientific assistant, should be appointed, together with laboratory and field assistants.

It is pointed out that the results obtained at the Central Research Station will probably not hold without modification for other regions, where the soil and climate may be very different. The basic principles, however, will be of wide application and will serve as a means of suggesting appropriate investigations for other countries, which might perhaps be carried out under advice from the Central Station.

It may be added that the recommendations made in this report have now been adopted by the Corporation, and steps are being taken to establish the Central Research Station in Trinidad.

Pulp-wood in Canada.—In 1923 the Canadian Government appointed a Royal Commission to make an enquiry into the pulp-wood situation in the Dominion, the terms of reference being " to enquire into and report on the forest resources of Canada with particular reference to: (*a*) the extent in each Province of wood of various kinds available for the manufacture of pulp; (*b*) the quantity of wood so available on lands owned by Provincial Governments and subject, under Provincial laws and regulations, to restrictions requiring the partial or total manufacture of such wood in Canada; (*c*) the quantity of wood so available on lands owned by the Dominion Government and subject, under Federal laws and regulations, to restrictions requiring partial or total manufacture in Canada; (*d*) the quantity of such woods on other lands, and the conditions under which such lands are held, whether by ownership or lease, whether by corporations or individuals, whether by citizens of Canada or citizens of other countries; (*e*) the quantity of pulp-wood produced in each Province of Canada during the past ten years, showing the portion used in Canada and the portion exported ; (*f*) the question of the prohibition or restriction of the export of pulp-wood from Canada ; (*g*) any other matter touching upon the production, manufacture or sale of pulp-wood essential to comprehensive consideration of the next preceding section (*f*) ; (*h*) the making of recommendations that may be deemed expedient for the better conservation of the supply of pulp-wood for present or future use."

The Commission consisted of Joseph Picard (Chairman) ; William A. Anstie (Deputy Chairman) ; Joseph G. Sutherland, R. W. McLellan and A. B. Kerr (Commissioners) ; and E. H. Finlayson, Acting Director of Forestry (Secretary).

The *Report* of the Commission, which has now been published as Sessional Paper 310 (Ottawa, 1924), consists of three parts dealing with (1) the question of actual pulp-wood supplies in various parts of the country, and the uses to which those supplies are put ; (2) questions of forest conservation, and recommendations in connection therewith ; and (3) the question of the prohibition or restriction of the export of pulp-wood.

It is not possible to give an adequate summary of this valuable and detailed report within the space of a few pages, but the following notes may be of interest as indicating its general trend.

In Part I of the *Report*, the pulp-wood resources of the various Provinces are reviewed in the following order : Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia ; and finally the resources of the Dominion are dealt with as a whole.

The total land area of the portion of Canada under review is 2,174,520 square miles, of which 1,216,408 square miles, or about 56 per cent., is forest. Of the forest area, rather more than 36 per cent. is regarded as merchantable forest, the remainder being inaccessible or only sparsely timbered. The total available stand of pulp-wood species is estimated at 630 million cords, of which 436·2 million cords consist of spruce, balsam and hemlock, distributed as follows : Maritime Provinces, 46·60 ; Quebec and Ontario, 215·50 ; Prairie Provinces, 49·10 ; British Columbia, 125·00 million cords.

The wood consumed in the Canadian pulp-mills in 1922 amounted to 2,912,608 cords, consisting of spruce, 2,032,985 cords ; balsam, 627,626 ; hemlock, 157,947 ; Jack pine, 79,461 ; poplar, 1,305 ; and all others, 13,284 cords.

The quantities of pulp-wood exported during 1922 and 1923 were 1,011,332 and 1,384,230 cords respectively; those of 1923 were supplied by: Nova Scotia, 11,451; New Brunswick, 173,828; Quebec, 760,328; Ontario, 414,288; Prairies, 80; British Columbia, 24,255 cords.

Prior to 1913 the quantity of pulp-wood exported exceeded that used in the Canadian mills, but since that date the opposite has been the case and the local demand has steadily surpassed the foreign demand until in 1922 the exports represented only about one-fourth of the total production. The exports during the six years 1917–22 consisted approximately of spruce 68 per cent., balsam 20 per cent., and poplar 12 per cent. In 1923, poplar was in greater demand, and in future this wood will probably form a larger proportion of the pulp-wood exports than formerly.

In addition to the utilisation of pulp-woods for home manufacture and for export, extensive use is made of the same woods in other directions, e.g. for fuel, railway ties, mine timber and construction timber. It is estimated that, including these, the total annual requirements of spruce, balsam and hemlock amount to at least 7 million cords.

The total value of primary wood products, viz. fuel, ties, logs, pulp-wood, square timber, etc. (excluding manufactured lumber and pulp) was over 170 million dollars in 1922. If to this is added the net value of saw-mill and pulp-mill products, the total value in the same year was upwards of 266 million dollars. If the value of paper products is also included, the total production exceeded 323 millions. Further, if the products of other manufactures in which wood is the essential material are added, the total value of wood production exceeds 400 million dollars. The saw-mills, pulp- and paper-mills, and the logging operations on which these depend, give employment to over 100,000 persons, and the capital invested in them is nearly 600 million dollars. Obviously, the preservation of an industry of such enormous dimensions is a matter of primary importance to Canada, and the maintenance and development of the forest industry is therefore imperative. Unfortunately, through several generations very serious inroads have been made on the timber supplies by extravagant exploitation and inadequate protection.

The Canadian pulp industry represents an invested capital of nearly 400 million dollars, and includes over 100 mills, most of which are in Quebec, Ontario, British Columbia and New Brunswick. Nova Scotia has several small mills, the output of which is not large, whilst the remaining Provinces have no pulp-mills at present. The combined value of pulp and paper manufacture amounts to over 140 million dollars per annum. The mills give regular employment to 25,000 operatives, whilst a further 25,000 workers are engaged at certain seasons in the cutting and removal of pulp-wood supplies. In 1922, the total production of wood-pulp in Canada was 2,150,251 tons, comprising ground-wood, 1,241,185 tons; sulphite pulp, 678,878 tons; sulphate pulp, 217,862 tons; and soda pulp, 793 tons. Of the total output, Quebec contributed 50·6 per cent., Ontario, 33·8 per cent., British Columbia, 9·2 per cent., New Brunswick, 4·6 per cent., and Nova Scotia, 1·7 per cent. (consisting entirely of ground-wood).

The paper manufacturing industry has made great progress, the total output in 1922 being 1,366,815 tons as compared with 853,689 tons in 1917. The products of the paper-mills in 1922 consisted of newsprint, 1,081,364 tons; book and writing papers, 64,808 tons; wrapping paper, 81,793 tons; boards, 113,200 tons; and miscellaneous, 25,650 tons.

In 1922, the total value of the pulp produced was about 85 million dollars. A quantity to the value of 41 millions was exported, of which over 33 million dollars' worth, or 80 per cent., was purchased by the United States, 17 per cent. by Great Britain and 3 per cent. by Japan.

In the same year, the total paper production amounted to over 106 million dollars in value. The value of the exports exceeded 75 million dollars, the United States taking about 65 million dollars' worth, or nearly 87 per cent. Newsprint accounts for over 90 per cent. of the total value of paper exported, and the imports into the United States in 1922 amounted to nearly 63 million dollars. According to the Census of Industry of the Dominion Bureau of Statistics "Canada supplies over 80 per cent. of the newsprint paper imported annually into the United States. Over two-thirds of the total consumption of newsprint by that country is either of Canadian manufacture or is made of pulp-wood or wood pulp imported from Canada."

The aggregate value of the pulp-wood, pulp and paper produced in Canada in 1922 was approximately $151,400,000; the purchases of the United States were about $108,400,000, or 71·6 per cent. of the total. The imports of pulp and paper into Canada during that year amounted to only $9,300,000, whilst the exports of the same commodities totalled $115,800,000, the gross contribution of the industry towards a favourable trade balance thus being more than 106 million dollars.

The total lumber production attained a maximum of 4·92 billion ft., board measure, in 1911, but since that time a decrease has taken place, the figure for 1922 being only 3·14 billion ft. During the period 1913–22, spruce provided 34·7 per cent. of the lumber produced ; Douglas fir, 19 per cent. ; white pine, 18 per cent. ; and hemlock, 7 per cent. ; the remainder was furnished by red pine, cedar, larch, birch, maple, balsam fir, yellow pine, and in smaller quantities by various other kinds. In 1922 the capital invested in the sawmill and allied industries was approximately 165 million dollars, and the total value of the products (excluding pulp-wood sawn at the mills) was 106 million dollars ; the sawmills gave employment to about 32,000 persons. Although on a smaller scale than the pulp industry, the lumber industry is of great magnitude and of outstanding importance. During the four years 1919–22, the average annual value of lumber, square timber, shingles and lath exported was $76,300,000, whilst the average annual value of the imports was $9,500,000. The difference, $66,800,000 was the contribution of these branches of forest industry towards attainment of a favourable trade balance.

Reference is made in the report to other branches of forest industry. The net production of the logging industry in 1922 (excluding the value of logs sawn into lumber, lath and shingles, or converted into pulp) was approximately 75 million dollars. This figure includes the value of fuel-wood, poles, posts, rails, mine timber and wood used for distillation, etc. The logging industry gives seasonal employment to about 35,000 persons.

Wood operations on the farms also, in the aggregate, constitute an industry of considerable proportions. In 1920, the total value of ordinary forest products on the Canadian farms was $67,700,000. If to this is added the value of maple syrup and maple sugar, the total is increased to over 72 million dollars.

The total value of the exports of all commodities from Canada in 1922 was about 885 million dollars, of which wood products contributed 210 millions or nearly one-fourth of the whole. The exports of wood products to the United States amounted to 175 million dollars, five-sixths of all the wood products exported thus going to that country. Further, of Canada's total exports to the United States, amounting to 340 million dollars, wood products accounted for more than one-half.

With regard to the duration of supplies, it is stated that after allowing for losses due to forest fires, insects and decay, the amount of available pulp-wood divided by the annual consumption gives a quotient indicating the existence of 63 years' supply. This result demonstrates the necessity for a thoroughly careful consideration of future supplies, and of means of terminating the present wasteful methods and of providing adequate forest protection. The annual loss of merchantable timber from fires in Canada is estimated at 800 million cubic feet and upwards of a million acres of young growth.

Forest fires are almost invariably followed by insect attacks, those trees which have not been killed by the fire being left in a weakened condition and thus very susceptible to such attacks. The insects still further weaken the trees and open up means of ingress for the spores of destructive fungi. During the last ten years, losses have been caused by the spruce bud-worm to the extent of 1,345 million cubic feet per annum, in addition to injury from bark beetles and other insects. The extent of the losses due to fungi is unknown.

The continuance of forest production on the present scale, apart altogether from the question of increasing the output, is absolutely contingent on very material reduction in the losses caused by fires, insects and decay.

In Part II of the *Report*, which deals with the fundamental principles underlying a policy of forest conservation for Canada, the Commission has pointed out the practical weaknesses and the business shortcomings of the present methods of forestry practice, and has made recommendations which are all regarded as essential to the formulation and execution of a rational forest policy in Canada. These are quoted verbatim below.

1. *Land Classification.*—(*a*) That the federal government should pursue more vigorously the classifying of lands which come under its control, with a view to assigning them to permanent forest production. The technical organisation for this work already exists: it requires expansion and greater financial support.

(*b*) That provinces which control their own resources should develop local machinery for land-classification work, and within their boundaries apply the procedure outlined in (*a*).

(*c*) That, owing to the existence in all provinces of the Dominion of large areas of unproductive land quite capable of producing forest crops, and to the national necessity that these lands should be put to economic use, it is incumbent upon the federal government, in addition to treating with lands directly under its control, to foster by whatever means or methods may be possible, a consistent and comprehensive plan of land-classification for all lands where there is question as to the proper economic use, throughout the Dominion. Great economy will be effected if the Provinces co-operate with the Dominion and concede to the latter the responsibility of bringing about standardised methods in this work.

2. *Dedication of Forest Lands.*—(*a*) That Dominion lands already classified as true forest lands should be permanently assigned to forest production by their creation as National Forests ; and that, as and when additional areas are classified as such, they too should be permanently dedicated.

(*b*) That similar action be taken in those provinces where direct control is exercised in forestry matters ; and that in Nova Scotia, in particular, definite provision be made, and concrete action be taken by the province, for the dedication as provincial forests of all timber lands remaining in the Crown, and the addition thereto of forest areas which may be acquired by purchase at reasonable cost, to the end that a reasonable proportion of the forest lands of that province may be placed and managed directly under public control.

(*c*) That the federal government exert all possible efforts in assisting to the consummation of the objects outlined in (*b*), so that, throughout the Dominion, there may be developed a complete chain of publicly owned forests. The position is not taken that all true forest lands should be in public ownership, for that might stifle initiative ; rather, that each province should have within its boundaries considerable areas of publicly owned and managed forests, in order to ensure continuity in supplies for forest industries, and to provide protection to stream flow.

3. *Forest Legislation.*—(*a*) That the federal government should thoroughly revise its forest legislation in such a manner as to make a clear definition of its forest policy, and more adequately provide for enforcement of principles of that policy upon lands subject to Federal control ; and that such legislation should make thorough provision for other forestry activities consequent upon the responsibilities of the federal government in developing, through co-operation with the provinces, a national forestry policy and programme of Dominion-wide application.

(*b*) That provinces exercising control over their forest resources should thoroughly review the legislation in which the forest policy is defined, and upon the basis of which their respective forest services operate, bringing into clearer definition the essential requirements of the policy, and providing for proper management of their forest lands. In cases where no comprehensive forest law now exists, action toward that end should be taken without further delay. There is no province or region in Canada where modern forest legislation is not urgently required for the proper conduct of the forest business.

(*c*) That for the accomplishment of both (*a*) and (*b*) the federal government, as far as the limitations of provincial autonomy may permit, exercise such effort as may be within its power to encourage and develop greater uniformity in forest legislation throughout the Dominion.

4. *Forest Authorities.*—(*a*) That the federal government, under the authority of more adequate legislation, suggested in 3 (*a*) above, should thoroughly reconstitute and enlarge its present forest service, centralising therein all functions pertaining to forest production, protection and management, now seriously scattered throughout various branches, to the detriment of economical and efficient administration; that in so doing primary consideration shall be given to the object in view; and that the policy to be formulated, and the service created for its enforcement, shall exhibit the extent and dignity justified by the handling of Canada's second greatest natural resource. In no manner should the proper management of true forest lands be limited or circumscribed by other considerations or organisations.

(*b*) That the organisation and status of the individual provincial services should be thoroughly reviewed by the respective governments, and that where weaknesses in the authority are found to exist, or where the carrying out of the fundamental principles of forest policy are being neglected, steps should be taken to improve conditions in that behalf; and particularly, that the province of Nova Scotia should definitely constitute a forest authority, for the purpose of developing and perpetuating the forest resources and forest industries of that province.

(*c*) That in reorganising its forest service full cognisance should be taken of the fact that the federal government has certain functions to perform even in provinces which control their own resources, and that the forest service must be properly constituted and provided with adequate funds to that end.

5. *Forest Protection.*—(*a*) That in view of the serious depletion annually sustained in forest resources on federal timber lands, more adequate financial provision should be

made, to permit of the present protective services being enlarged upon and greatly improved; that in making such financial provision, recognition be given to the fact that forest protection entails the provision of adequate improvements and facilities, which should be considered as capital expenditure.

(*b*) That similar action be taken by the provinces which exercise the function of forest protection, to the end that forest resources within their boundaries may be more adequately protected.

(*c*) That for reasons which have been rather clearly explained, there exists every justification and necessity for the participation by the federal government in measures aimed at protection of the forest resources in all provinces. In the time which the Commission had to study the matter, we are not in a position to explain in detail the steps which should be taken. We may strongly urge, however, that the provision of funds from the Federal treasury, even for forestry work in the provinces, is quite in keeping with Federal responsibilities, there is great need for Federal aid to, and co-operation with the individual provinces, both in the solution of the fire problem, and in the control of forest insects and forest diseases. At this stage the Commission strongly commend the action recently taken by the federal government, in calling a conference of provincial ministers and forest officials for the discussion of fire protection problems. The extension of this idea is strongly urged, in order that the forest authorities throughout the country may recognise the inter-relation, as between the different provinces, of the forest fire problem.

Note: The provision of more adequate facilities for fire protection is of paramount importance. Roads, trails, telephones, look-outs, air-craft, and numerous other works, are an essential requisite, and even at heavy immediate capital expenditure will quickly repay their cost in the timber saved by their use.

6. *Forest Surveys and Inventories.*—(*a*) That the federal government should enlarge its organisation for the survey and inventory of the forest resources of Canada, and that it should co-operate fully with the provinces in providing, at as early a date as may be possible, much more reliable data regarding the extent of forest resources in various parts of the Dominion than are now available.

(*b*) That within their boundaries the provinces should exert in greater intensity the function of forest surveys, and co-operate with the federal organisation in the securing of preliminary forest inventories.

7. *Forest Management.*—(*a*) That the federal govern-

ment, after the proper constitution of the forest service, should thoroughly revise the legislation and methods in which timber is disposed of on lands subject to federal control, incorporating in such all those essential features of forestry which economic conditions may permit.

(*b*) That the provincial forest authorities should also take the action defined in (*a*).

(*c*) That owing to the great desirability of standardising, so far as may be possible, regulations under which timber is disposed of, and to make provision for the proper study of the economics of taxation of timber lands, the federal government should make provision in its forest authority for a unit definitely organised for that purpose.

(*d*) That on federal forest reserves, such areas which now present opportunities for intensive management for sustained yield should be immediately brought under measures to that end.

(*e*) That similar action be taken in the provinces for certain areas of lands already reserved, where economic conditions permit.

(*f*) That, on account of the fire hazard presented by woods' slash, some definite action must be taken to provide for the proper treatment of slash in logging operations.

8. *Tree planting and Woodlots.*—(*a*) That the federal government continue and enlarge upon its present tree-planting work in Western Canada.

(*b*) That similar action be taken in the eastern provinces.

(*c*) That for both federal and provincial land there should be developed within the individual forest services units which would exercise the function of giving advice and help to farmers throughout the country in the management and treatment of their woodlots.

(*d*) That efforts in this direction should not be permitted to overshadow 9 (*c*), following.

9. *Silvicultural Research.*—(*a*) That the programme of silvicultural research and growth studies, now engaged in by the federal service, should be considerably enlarged upon in order that more of the main problems underlying the development of proper forest management should be brought more quickly and generally to their proper solution.

(*b*) That forest authorities of the provinces should continue to co-operate with the federal service in silvicultural research work, and themselves engage in work of this character where the solution of purely local problems is essential to the development of proper plans for management.

(*c*) That forest experiment stations are urgently required throughout the Dominion, not only for the progress of silvicultural work, but also for the purpose of demonstrating to the people the objects and results of proper forest management.

10. *Forest Expenditure.*—(*a*) That throughout the Dominion there be more thoroughly recognised, that in the protection and management of forest lands a much larger part of the revenue extracted therefrom must be returned to the forest; that this is all-essential, even though other sources of revenue must be resorted to.

(*b*) That owing to the time element involved in all phases of forest practice, methods should be devised and applied whereby the forest services may be assured of continuous appropriations to cover at least those phases of their work which demand assurance and continuity in funds.

11. *Forestry Conference.*—(*a*) That following upon the British Empire Forestry Conference held in Canada during 1923, and the Conference of Dominion and Provincial officials held in January last, there should, within a period of one year, be called a general conference to include, not only government representatives and forest officials, but also qualified representatives of the forest industries, or others interested in various phases of forest activities, for the purpose of discussing the ways and means for the improvement of methods in forest utilisation and protection, and for determining the applicability of any measures which may be presented to such conference in the conduct of forest business.

In connection with the question of the desirability of prohibiting or restricting the exportation of pulp-wood from Canada, dealt with in Part III of the *Report*, the Commission have heard and considered the arguments of the various classes interested, viz. pulp and paper manufacturers, private individuals, forestry experts, boards of trade, lumbermen, farmers and settlers, timber-land owners, and pulp-wood exporters. Views have been advanced (1) that there should be a complete embargo on the export of pulp-wood, or an export duty designed either to reduce the amount annually exported or to prevent further increase in such exports, and (2) that no restrictions should be imposed. Between the classes holding these opposite views are various sub-classes differing in the degree to which they support or oppose restriction. The national aspect of the problem must, however, in the final analysis, be the basis of decision, since, in so far as the continued success of farming interests, of lumbering interests and of pulp-manufacturing interests depends on the timber resources of the Dominion, the interests of one and all of these must obviously be made subservient to the continuance of the forest resources as a whole and to national development and security.

The Commission express the opinion that steps must certainly be taken to reduce the annual drain on the spruce and balsam supplies of Eastern Canada, and, while considering that in some parts the object may be attained by the elimination of losses due to fire and insects, they are convinced that, in other cases, it is necessary that, in addition to the elimination of these losses, some reduction must be made in the amount of spruce and balsam used in local industries or exported. The same situation does not exist in British Columbia and suggestions are made as to means by which legislation could be effected without being unduly harmful to British Columbian interests.

Finally, the Commission express the view that " owing to the many intricacies involved in the pulp-wood export question ; in the complications as between forest conservation and trade relations ; in view of the fact that the character and extent of the restrictions would necessarily depend upon the extent to which the Government might otherwise go in conservation ; finally, as the facts have been very plainly and fully laid before the Government,—the Commission takes the view that the actual determination of a policy must rest with the Government."

Indian Pulp and Paper Industries.—In 1923 the question of a grant of protection to the Indian paper industries was the subject of representations made to the Government of India by the Indian Paper Makers' Association, which consists of the Titaghur Paper Mill Company, Ltd., and the Bengal Paper Mill Company, Ltd. Early in 1924 the India Paper Pulp Company, Ltd., joined in this demand and also asked that a protective duty might be imposed on imported paper-pulp. The claim was referred to the Indian Tariff Board in order that the case for protection might be fully investigated. The *Report* of the Board has now been published (Calcutta : Government of India Central Publication Branch, 1925).

There are, at present, nine paper mills in India, but some of them are of little importance, and practically the whole of the industry is carried on in five mills, the full capacity of which is about 33,000 tons of paper per annum.

Two new mills are projected, one of which has been partially constructed at Rajahmundry in Madras by the Carnatic Paper Mills, Ltd. This mill, when completed, will be capable of producing about 1,600 tons of paper annually from straw and eventually of manufacturing also 3,000 tons from bamboo. The other mill is to be erected near Saharanpur in the Punjab by the Punjab Paper Mills Company with a capacity of 6,000 tons per annum.

The Indian paper-maker has hitherto depended chiefly on sabai grass (*Ischæmum angustifolium*) for his raw material, the pulp from which is commonly used in admixture with imported wood-pulp. Considerable quantities of rags, and hemp and jute waste are also used in the mills, together with a certain amount of waste paper. The India Paper Pulp Company are making paper from bamboo at Naihati on the Hooghly by means of a modified sulphite process devised by J. L. Jardine (see this BULLETIN, 1920, **18**, 421).

The production of paper in India in 1923 amounted to only 27,000 tons, whilst, in the year 1923–24, 72,000 tons were imported. The imports include certain kinds of paper which are not likely to be made in India, such as newsprint (containing about 70 per cent. of mechanical wood-pulp), expensive rag papers, art papers, tissue papers and cheap wrapping papers. Probably not more than one-third of the imports would come into competition with Indian paper, and the market which India might conceivably capture under a protective system would not exceed 20,000 tons per annum.

The cost of production of paper in the Indian mills is fully discussed in the *Report*, and it is shown that, since the war, the lowest cost at which paper has been made using sabai grass as the staple material is Rs.490 per ton. It is considered that certain economies could be effected and that, in course of time, a well-equipped mill near Calcutta, or in the coalfields, might be able to produce at about Rs.420, but not below Rs.400 per ton. The manufacture of paper from bamboo is at present only in an early stage and the lowest cost so far achieved is Rs.440 per ton. The mill at Naihati is only equipped with one machine, although designed for two, and if a second machine were added it is probable that in the course of four or five years the cost could be reduced to Rs.360 per ton.

The two objects for which protection for paper-pulp was demanded were to free the Indian paper industry from dependence on foreign materials, and to develop eventually an export trade in bamboo pulp, the first, from the point of view of the India Paper Pulp Company, being only a stepping-stone to the second. The evidence placed before the Board, however, did not indicate that a large increase in the cost of wood-pulp is so imminent that export of bamboo pulp will become possible in the near future, and the opinion was formed that the proposal for a protective duty on imported paper-pulp cannot be supported. The imposition of such a duty might compel Indian mills, which use grass as their staple material, to substitute bamboo pulp for imported wood-pulp, but it is not likely that a separate bamboo pulp industry would come into existence, for the grass mills would doubtless make arrangements to manufacture bamboo pulp for themselves. The suggested duty, therefore, would not achieve the desired result.

The Board recommend that, in order that the manufacture of paper from bamboo may be fully investigated, capital to the amount of Rs. 10 lakhs should be advanced by the Government for the purpose of enabling the India Paper Pulp Company to increase the output of its mill from 2,500 to 5,000 tons per annum. As already stated, this Company is using the sulphite process. The Carnatic Paper Mills, Ltd., apparently intend to make bamboo pulp by the soda process, but are not yet in a position to commence manufacture. It is desirable that this project should be explored and that, if the Company can show reasonable prospects of success, they should receive similar assistance to that proposed for the India Paper Pulp Company.

Further, the Board recommend that in place of the existing 15 per cent. *ad valorem* duties on printing paper and writing paper, a specific duty of one anna per lb. should be imposed on all writing paper and on all printing paper, other than newsprint containing 65 per cent. or more of mechanical pulp. No change is proposed in the duties on other kinds of paper.

Newfoundland Cod-Liver Oil.—As long ago as 1840 Newfoundland was producing and exporting cod-liver oil, and since that time the Newfoundland manufacturers have endeavoured to keep abreast of all improvements in the methods of preparing the oil. In 1888 they adopted the process of refining, which consists of removing the stearin by chilling the oil. In 1903 the direct steam process was introduced. In 1916, by an Act of the Newfoundland Legislature all the cod-liver oil production of the Dominion was put under the control of the Ministry of Marine and

Fisheries. Every manufacturer is now required to hold a licence issued by this Department and to use the direct steam method for the preparation of the oil, and also to comply with various rules laid down to ensure cleanliness, and to prevent the use of discoloured and stale livers.

Dr. S. S. Zilva and Dr. J. C. Drummond, who visited the cod fisheries of Newfoundland, have described the method used there for the preparation of the oil and have published the results of their investigation of the quality of the Newfoundland product (*Journ. Soc. Chem. Ind.*, 1923, **42**, 185T, 250T). More recently, the latter author has shown that the Newfoundland oil is of equal vitamin potency to that obtained from Norway (*Lancet*, 1925, **209**, 679).

In the Newfoundland fisheries most of the fish are caught, within a mile or so of the shore, in traps, which are overhauled twice a day ; the oil is usually prepared soon after the fish have been taken from the water. The cod are generally gutted by hand on the quay as brought in, but recently mechanical splitting machines have been introduced which tests have shown to be quite satisfactory. The livers after removal are washed in clean fresh water, then placed in steam pans, where they are treated with open steam (usually for 30 minutes) until a white scum floats on the top of the liquor. The steam is shut off and the liquor allowed to settle for five minutes. The oil is then decanted, and strained through flannel, calico or moleskin into a cooling tank, where it remains till the following day. It is then dipped and strained through a double calico bag ; thence it passes through cheese cloth into casks. This first fraction from the livers, known as " ordinary refined," is the only fraction used for medicinal purposes. The residue from the livers (or " blubber ") is steamed again, giving " common cod oil," which is only a little darker in colour than the first fraction and not quite so rich in vitamins. The first fraction is submitted to a process of refining before use. As this process requires more or less costly plant, it is mostly carried out by the larger concerns, who refine their own oil as well as that of smaller firms. Refining consists of chilling the oil and the removal of the separated stearin. For this purpose the oil is kept in tin vessels at 18° F. for about three days, the refrigeration being effected by means of an ammonia plant. The oil is then decanted and allowed to drain from calico bags of about one and a half gallons capacity into a reservoir. After a further 36 hours it is strained through muslin and transferred to tin-lined barrels.

The bags containing the stearin are pressed and the expressed oil is added to the main bulk.

The medicinal value of cod-liver oil depends on the vitamins contained in it. The chief factor governing the amount of these principles in the livers is the nature of the food supply of the fish at the time of being caught. When the fish are actively feeding the livers are usually rich in vitamins and yield a pale yellow oil of very high medicinal value. On the other hand, during spawning, when the fish are practically starving, and are at the same time transferring much fat and vitamin to the reproductive cells, the livers yield an almost white oil of relatively low vitamin potency.

Of the oils derived from Norway, those from the Finmarken coast, which are prepared not only from the cod but also from various other gadoid fish caught when actively feeding, are, generally speaking, five to ten times more valuable than the average oil prepared in the Lofoten area, where during a portion of the season the fish are caught when spawning. The Newfoundland oils were found to possess a very high average vitamin content, and this is ascribed to the fact that the main fishing season is in the summer months, when the cod are actively feeding off the east coast of the island. The oils made during this period have, therefore, a high vitamin value, and are comparable with the Finmarken oils, with the exception that those from the Dominion are prepared practically entirely from cod. Only a very small proportion of the fish used for the manufacture of Newfoundland oils are caught when spawning. Oils from fish caught in different localities off the island showed no difference in potency, all being of very high vitamin content.

Until recently, the sale of Newfoundland cod-liver oil for medicinal purposes was comparatively small owing to the strong preference shown for the Norwegian product, especially that from the Lofoten area. Although in the past the Norwegians undoubtedly captured the market by the obvious superiority of their products, there is no longer any ground for this preference, as has been proved by the investigations described. The superiority of the Norwegian oil over that from the Dominion has disappeared through the improvement of the quality of the latter.

That in the Newfoundland fisheries the British Empire possesses a source of cod-liver oil of very high quality, is further supported by the fact that a number of the chief firms in the United States of America have decided to erect their own factories in the Dominion or to employ only Newfoundland oil.

The Vegetable Oil Industry of the Punjab.—The present condition of the vegetable oil industry of the Punjab and means for its improvement have recently been investigated by Mr. John Brewis, of Messrs. George Scott & Son (London), Ltd., Silvertown, E.16, the well-known firm of chemical engineers and specialists in solvent extraction plant, and the results have been issued by the firm in the form of a publication entitled *Report on the Vegetable Oil Seeds and Associated Industry of the Punjab.*

The seeds which are available for crushing in the Punjab comprise rape (sarson, taramira and toria varieties), cotton, sesame, linseed, mowra and castor seed. Rape and cotton seed are grown to the largest extent, but the latter is rarely crushed, practically the whole crop being fed to cattle or exported. The oil is extracted either by the native appliances called "ghanis" or "kohlus," or by hydraulic presses. Over 90 per cent. of the total oil manufactured is prepared by the native processes, the plant for which is a form of pestle and mortar, driven by bullocks or power. Tables are given, showing the yield of oil and cake and the working costs of a number of mills employing these methods. Recommendations are made for the improvement of the existing mills using hydraulic presses, and a comprehensive scheme is outlined for the general improvement of the industry. This entails the erection and working of a model mill; the creation of a new Government department for controlling the industry; the training of students in colleges and mills to fit them to become mill managers, and the appointment of a specialist officer to supervise the new department which, it is suggested, should not be under the control of the Agricultural Department but should work in close collaboration with it. It is not proposed that the model mill should at first contain anything more than the requisite plant to produce crude oil of good quality and saleable cake, but later, refining plant and plant for the preparation of artificial butters, and for the manufacture of soap and the concentration of glycerine, could be added. It is recommended that the plant to be installed in the first place should consist of two solvent extraction units and four Anglo-American presses as a minimum. Such a mill would be capable of working 160 to 210 tons of seeds per week of 132 hours. The labour required is 101 men; the cost of the equipment, exclusive of the power and steam plant, would be about £12,500 f.o.b. England.

In addition to the foregoing suggestions for improvement to be undertaken by the Government, the development of the industry can be helped by private enterprise.

It is recommended that interested firms should erect small mills equipped with modern plant. The use of the solvent extraction method is advocated and its advantages are pointed out.

At present, the refining of vegetable oils is practically unknown in the Punjab and it is suggested that it should not be undertaken until further enquiry has shown that refined oils would be marketable in the Province; at present the natives are not accustomed to refined oils and in many cases are prejudiced against them.

The crushing or extraction of oil from cotton seed on a large scale in the Punjab is not advocated. The great bulk of Indian cotton seed is not of good quality for milling and often contains a lot of "dead" seed, while its oil content is low, viz. 16 to 18 per cent. The seed would have to be decorticated, and for this operation special plant would be required. Moreover, it is difficult to dispose of cotton seed cake locally, as the farmers are prejudiced against its use. In order for a cotton seed mill to be a commercial success, it would have to be of large size and erected close to a ginnery.

Other sections of the *Report* are devoted to the manufacture of soap and vegetable butters. For the former purpose there is a lack of raw material available in the Punjab and a locally-made product would have to meet the strong competition of the imported article. Vegetable butters are unknown in the province and an investigation into the commercial and technical possibilities is necessary before the manufacture of products of this class is undertaken. The *Report* is illustrated with photographs of modern oil machinery.

Portland Cement. Revised British Standard Specification.—In connection with the articles on "Cement Manufacture and its Possibilities in the Crown Colonies and Protectorates," which have appeared in this BULLETIN, it is of interest to note that the British Engineering Standards Association have just issued (October 1925) a further revision of the British Standard Specification for Portland cement.

This revision is the work of the Association's Sectional Committee on Cement, upon which the Imperial Institute was represented by Mr. S. J. Johnstone, B.Sc., F.I.C., of the Institute staff.

The present specification differs from its predecessor (issued in 1920), principally in the following particulars:

(1) The maximum amount of magnesia allowed is raised from 3 to 4 per cent.

(2) The maximum tensile strength of the neat cement at 7 days after gauging is raised from 450 lb. to 600 lb. whilst the 28-day test is abolished.

(3) The minimum tensile strengths of the cement-sand briquettes at 7 and 28 days after gauging are increased to 325 lb. and 356 lb. respectively. The character of the sand to be used for the test is more closely specified than heretofore and a formula is given which must be employed for ascertaining the amount of water to be used in gauging the briquettes.

(4) Changes have also been made with regard to the hydraulic modulus, fineness and Le Chatelier tests.

Although in many respects the revised Specification is more stringent than that of 1920, the increase in the maximum amount of magnesia permissible makes it possible for certain limestone deposits to be utilised for cement-making which have previously been excluded on account of their high magnesia content.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

Foodstuffs

Sugar Cane.—An experiment was conducted in 1922 at the La Carlota Experiment Station, Occidental Negros, Philippines, to determine the losses caused by mosaic disease, and the details and results have now been reported in the *Philippine Agric. Rev.* (1925, **18**, 33). The cane grown was Negros Purple, the standard variety for the district, and the results showed that the yield of cane was greatly reduced by the disease, the average reduction being 61·28 per cent. per hectare. The disease affects the amount and purity of the sucrose, and this effect becomes very noticeable when sugar is made on a commercial scale. The yield of sugar per hectare was reduced by 70·63 per cent. Data so far obtained show that 98 per cent. of the young plants inherit the disease. Although the disease had a marked effect on the weight of cane, it had no effect on the stooling power of the plants. The disease has spread so greatly in certain localities of the Philippines that the amount of infection ranges from 40 to 60 per cent. This increase may be due to lack of care on the part of the planters in selecting points for planting or to continuous ratooning and poor cultivation, and it is stated that there are still planters who consider the damage so insignificant that it can be ignored. The experiment recorded demonstrates the serious loss caused by the disease, and planters are recommended to practise the selection of points from healthy plants.

Sugar Beet.—*The Scottish Journ. Agric.* (1925, **8,** 300) gives a summary of the Report (dated March 1925) of the Committee appointed by the Scottish Council of Agriculture to investigate the prospects of sugar beet growing in Scotland. It is considered sufficiently proved that sugar beet can be grown as satisfactorily in that country as on the Continent, with regard to quality and quantity of crop per acre. The question at issue is whether a sufficient area of beet could be secured within a radius of from 30 to 40 miles of a central site to induce the establishment of a sugar factory. It is understood that arrangements were made for the planting of a considerable area in 1925 in Ayrshire, Easter Ross, Argyll and elsewhere, and for the opening of a sugar factory at Greenock.

Following this summary is an article on sugar beet growing in the North of Scotland. In the Moray and Nairn district, trials in 1924 produced from 8 to 10 tons per acre of unwashed beets, with a variation of 16 to 17·9 per cent. of sugar, while trials in Aberdeenshire gave from 3 to 8 tons per acre of unwashed beets, and a variation of 15·9 to 17·4 per cent. of sugar. In the Cromarty district 12½ tons per acre of unwashed beets were obtained, having a sugar content of 19·2 per cent. There are not sufficient data at present to state whether the growing of beet will be profitable to the farmer, but the cost of production of an acre of beet in the Moray Firth districts is estimated at £15 15*s*., while the rate of purchase arranged by the newly formed Highland Sugar Beet Syndicate for 1925 provides (after deducting transport charges) an estimated return of £20 11*s*. per acre, based on a yield of 9 tons of beet (containing 17·5 per cent. of sugar) and a price of 49*s*. per ton. The establishment of a factory in the Moray Firth district is contemplated.

Rice.—*Bull. Écon. de l'Indochine* (1925, **28,** No. 171, p. 163) contains a study of the world's production, commerce and consumption of rice, the period reviewed being for the years 1920 to 1923 inclusive, for which detailed statistics are given, whilst 1924 figures are included where available. The world's production of paddy in the year 1923–24 amounted to roughly 1,270 million quintals, of which India produced 484 and China 420, the next largest grower being Japan with 107 quintals. The annual average consumption in the four years 1920 to 1923 amounted to 770 million quintals of rice in India and the Far East and 36 quintals in the rest of the world.

Med. van het Instituut voor Plantenziekten, No. 66 (1925), *Dep. van Landbouw, Ned. Ind.*, deals fully with the life-history and control of the white rice borer (*Scirpophaga serica* = *S. innotata*) in Java. The results of five years' investigations are given, according to which the most important factor in the problem is the time of planting. The damage may be considerably reduced by selecting the best dates for sowing the seed, and for transplanting. It is suggested that legal power should be obtained to enforce late sowing in districts where it is deemed advisable.

Tea.—" The Control of Shot-Hole Borer of Tea " is the title of *Bull. No. 72, Dep. Agric. Ceylon*, which deals with experiments carried out to determine the effect of manures on the activity of this borer, *Xyleborus fornicatus*, the records being prefaced with a summary of the control measures which have been investigated in the past (see this BULLETIN, 1923, **21**, 509). The primary damage caused to tea bushes by the shot-hole borer is the weakening of the branches by the formation of galleries, rendering them liable to be readily fractured by coolies when plucking and even by high winds. It was considered that the increased vigour due to manuring might result in fewer galleries being constructed in the branches, smaller colonies being raised in the galleries, or in the stimulation of healing of the entrance holes, resulting in the strengthening of the branches. It was found that the application of a general manurial mixture increases the vigour of the bushes, and throughout the experiments the healing of galleries was more pronounced on the manured plots than on the control plot, the rate of healing being greatest during the second year of the experiments. The application made the bushes neither more nor less attractive to the borer, but it had a beneficial effect in reducing the number of insects produced on the bushes.

Coffee.—An interesting article on the Haitian coffee industry appears in *Commerce Reports* (No. 28, July 13, 1925, p. 97). The importance of the crop is seen from the exports for 1923–4, which amounted to the value of $10,400,000, while the exports of next importance, cotton and cotton seed, did not quite reach $2,300,000. About 70 per cent. of the coffee is grown in the south, about 10 per cent. in the central section, and 20 per cent. in the north, practically the entire crop being grown by peasant farmers on farms of less than 10 acres. Approximately 80 per cent. of the exports goes to France, and less than 2 per cent. is purchased by the American coffee trade. Haitian coffee falls into four principal classes: "Tel Quel," "Epierré," "Trié" and "Triage." The first is the coffee as it arrives from the farmer, and consists of a mixture of perfect and imperfect beans, together with stones and dirt. "Epierré" is the coffee after foreign matter and some of the most imperfect beans have been removed. "Trié" is hand-picked coffee, i.e. coffee which has had foreign matter and black and imperfect beans removed by hand. "Triage" is the imperfect coffee which has been removed from the "Tel Quel" in order to secure the "Trié." The first three classes are each divided into three qualities. No. 1, the highest grade, is a hard, green coffee in mixed sizes, No. 2 is a softer, greyish green coffee, while No. 3 consists of soft grey beans. In addition there is the washed coffee, "Café Gragé," which is produced in limited quantities, is a hard, green bean grown at the higher altitudes and is the finest coffee produced in Haiti. Small quantities of a peaberry coffee, "Caracoli," consisting of small round beans, are also produced.

Circ. No. 13 (1924), *Dep. Agric.*, *Uganda*, entitled "The Coffee Bug" (*Antestia lineaticollis* Stal., var.), gives an account of the life-history and control of the coffee bug. It contains the results of one year's work in Uganda on the part of the author, H. Wilkinson, Assistant Entomologist, together with his observations on most of the Kenya coffee estates during a period of 2½ years.

OILS AND OIL SEEDS

Chinese Wood Oil.—Considerable experimental work continues to be carried out in connection with the cultivation of Chinese wood oil trees in Florida. According to *Circ. No.* 241, 1925, *Paint Manuf. Assoc. U.S.A.*, *Sci. Sect.*, *Educ. Bur.*, a hundred two-year-old seedlings from the Georgia Experiment Station have been planted in

Paradise Grove, Gainesville, with the object of determining whether seedlings raised farther north would be more hardy than those raised in Florida. It is questionable, however, whether more hardy tendencies will be shown. Manurial experiments indicated that nitrate of soda, Peruvian guano and cow or horse manure may prove much safer than the type of fertiliser previously used, which caused " burning " in some sections of the plantation. It is apparent also that an organic source of nitrogen, in conjunction with nitrate of soda, will give the best results. During the winter months oats were planted between the rows of trees, as this crop keeps the ground from being washed away by rains and also provides a supply of fodder early in the spring. Crotalaria has so far proved to be the best cover crop. The plants, which grow 5 or 6 ft. in height, shelter the tung oil seedlings from wind and excess of sun and enrich the soil, whilst the seed produced can be sold. The crop is sown at the rate of 3 lb. of seed per acre.

Crushing tests have been made on tung oil seed imported from China and have shown that by the use of modern machinery a lighter-coloured and higher grade of oil than that usually imported can be readily obtained. A machine that is apparently satisfactory has been developed for removing the outer husk and inner shell from tung oil seeds.

Oil-palm.—The insects which so far have been found damaging oil-palms in Malaya comprise eight species (*Malayan Agric. Journ.*, 1925, **13**, 250). Of these the following four also attack coconut palms: rhinoceros weevil (*Oryctes rhinoceros*), which can be controlled by taking care to remove all refuse from oil-palms to prevent it becoming a breeding-place; the red-stripe weevil (*Rhynchophorus schach*), which lays its eggs in damaged tissues and which should be prevented from entering the pruned ends of the petioles; the nettle caterpillar (*Setora nitens*) and the coconut case worm (*Mahasena* sp.), both of which occur, especially on young palms, and may be controlled by spraying with lead arsenate. Up to the present none of the eight insects has caused any serious damage on oil-palm estates. In West Africa oil-palms do not appear to have suffered seriously from attacks of insects, probably because they are widely distributed among other trees, but it is expected that palms growing under plantation conditions in Malaya will suffer more. It has been found that insects which attack both coconuts and oil-palms show a preference for the former, and this may be the reason why the rhinoceros beetle and the red-stripe weevil have not hitherto harmed oil-palms in Malaya to any extent. In connection with insect pests attacking oil-palms in Malaya two sources of danger must be watched, namely, the adaptation of local coconut pests to the oil-palm and the importation of harmful insects.

The results of investigations which were started at the General Experimental Station, Medan, in 1921 on the ripening of palm fruits have been published as a preliminary paper (*Comm. Gen. Exper. Stat. A.V.R.O.S., Gen. Ser.*, 1925, No. 20). The questions considered related to (1) the rapidity of the formation of oil in the fruits and the effects of gathering them before and after they have ripened ; (2) the length of time for which the maximum oil content is maintained after ripening ; and (3) the changes in the quality of the oil that may arise through the ripe fruits being so kept. It was found that oil forms in the fruits very rapidly, the time taken for it to reach the maximum under conditions prevailing in the neighbourhood of Medan being about 24 days. A loss of oil results if the bunches are unripe when gathered, as the oil content does not increase when unripe fruits are stored. There is no objection to harvesting over-ripe fruits, provided that not more than three days have elapsed since they reached maturity. Bunches can be most economically gathered in Medan at intervals of five days. The bunches reach their maximum oil content when several fruits on the outside of the bunch loosen naturally. After reaching maturity the free fatty acid content begins to increase slowly, but even after three days the increase is only 0·6 per cent. The oil in fruits from undeveloped bunches was found to have about the same acidity as that prepared from ripe fruits.

Perilla Seed.—In continuation of the experimental work on perilla seed cultivation in the United States, which was carried out in 1917, further plantings were made in 1925 at Athens, Ga., and Gainesville, Fla. Four acres at each place were sown with seed, imported from Japan, in rows 3½ ft. apart and 1 in. deep, 3 to 4 lb. of seed being used per acre. When the plants were well up, they were to be thinned out so as to leave one plant per foot. When ready for harvesting they should be about 6 ft. high. At these same places, small acreages were also sown with Chia seed (*Salvia hispanica*) imported from Mexico (*Sci. Sect., Educ. Bur., Paint Manuf. Assoc. U.S.A.*, 1925, *Circular No.* 241).

Shea Nuts.—It is proposed to erect a factory at Bamako, French Sudan, at a cost of 500,000 francs, to treat shea nuts (*Rev. Bot. App. Agr. Colon.*, 1925, **5**, 536). The capacity is to be such as to treat 20 tons per day or 6,000 tons per year of 300 working days. The quantities of the nuts available in West Africa are enormous, and it is calculated that every year 500,000 tons in French West Africa and from 200,000 to 300,000 tons in Nigeria are lost. Owing to the shea trees being rather widely scattered through the forests, the nuts in many cases will have to be sent a considerable distance to the factory. It is therefore proposed to dry the nuts partially before transporting, so that they may arrive at Bamako in sound condition. In the factory, the undecorticated nuts are to be extracted by means of a non-inflammable solvent, such as trichlorethylene, the residual meal being used as fuel.

FIBRES

Cotton

Nyasaland.—The progress of the cotton industry in Nyasaland during 1924 is reviewed in the *Ann. Rep. Dept. Agric., Nyasaland Protectorate for* 1924. The area devoted to the crop by European planters amounted to 26,120 acres and the production to 15,422 cwts. of lint. The best results were obtained on the Lower River, especially in the Chikwawa district. In the Shire Highlands, the occurrence of late rains had an adverse effect on the crop, and a large amount of boll-rot and stained cotton was observed which was caused chiefly by a fungoid organism introduced by stainers when puncturing the bolls. The repeated cultivation of cotton on the same land, without any rotation and without manuring, renders the plant less resistant to the attack of both insect and fungus, and it is therefore considered that the best remedy would be to allow the land to lie fallow for one or more seasons. Owing to the variation in the amount and incidence of the rains, it is practically impossible to select a strain of cotton which would give good results in all seasons. The only means of obtaining any stability in the production would be to bring under irrigation large areas of land with an elevation of less than 2,000 ft.

The amount of cotton produced by the natives in 1924 was the largest on record, and this was partly due to the excellent instruction given by the agriculturist in charge of the Lower River districts, to the generous assistance of the staff of the British Cotton Growing Association, to favourable weather and to relative immunity from insect pests. The quantity of seed-cotton produced was 1,369 tons, as compared with 747 tons in 1923 and 387 tons in 1922.

Valuable assistance was rendered by the Empire Cotton Growing Corporation, and the selection work done at the Corporation's new experimental station was of great interest and promises to lead to important results.

Peru.—An account of cotton cultivation in Peru has been published in the July, August and September issues of *Peru* (1925, **2**, 9, 53, 93). The Peruvian coast has a very low rainfall, and irrigation therefore has to be practised throughout the cotton-growing season. If the cotton is planted during the period September–November, a progressive increase of temperature occurs and simultaneously an increase takes place in the quantity of water available for the crop, as at that time the volume of water in the rivers which irrigate the valleys becomes greater. The soil is formed by the alluvium brought down by the rivers from the high Corderillas and is well adapted to cotton cultivation in respect of both physical structure and chemical composition.

The yield of cotton per hectare is greater than that of any other country. In the Zana Valley the average yield from *Gossypium hirsutum* is 1,297 lb. per hectare; in the Valleys of Chancay, Huacho, Lima, Lurin and Mala the yield fluctuates from 900 lb. to 2,076 lb. per hectare; in the Valley of Chincha the average production is 1,211 lb. per hectare; and in the high parts of the Valley of Ica 1,405 lb. per hectare. In the Valley of Pativilca, the Sea Island variety (*G. barbadense*) gives an average yield of 970–1,107 lb. per hectare, and in the Valley of Chira the Mitafifi variety yields 1,384 lb. per hectare. The yield of the perennial indigenous cotton (*G. peruvianum*) in the Valleys of Fiura, Sechura, Catacaos and Chira, where it is grown on the largest scale, is only 392 lb. per hectare in the first year of its growth, but averages 588 lb. per hectare in later years. This Piura cotton is known in the market as "fully rough Peruvian." The same variety is grown in the Valleys of Ica and Palpa, but the fibre produced there is less rough and is termed "moderately rough Peruvian"; the yield is 908 lb. per hectare.

The best cotton grown in Peru is said to be the "Tanguis" variety, which was evolved by Don Fermin Tanguis by careful selection. The variety is immune from wilt disease and gives a higher yield of cotton than any other kind grown in the country. The seed is very small and the ginning yield amounts to 40–42 per cent. The fibre is of unsurpassed quality, is very white, and also strong and resistant. Although this cotton has been in existence for only a few years, it is now produced in larger quantities than any other variety.

The area devoted to cotton in Peru in 1923 amounted to 121,916 hectares. The Government has endeavoured to increase the area suitable for cotton cultivation by irrigation schemes, and by means of the Pampas Imperial Irrigation Scheme has already rendered an additional 8,000 hectares available for the crop. It is hoped that a new scheme, the Pampas Olmos Irrigation Scheme, which is now being energetically undertaken, will add not less than 40,000 hectares to the area under cultivation.

The exports of cotton from Peru have only become of importance since 1900, when they amounted to about 800 metric tons. From that time the cultivation has increased rapidly, the exports in 1908 being 16,000 metric tons.

The quantities produced and exported during the years 1916–23 are given in the following table :

Year.	Production. *Metric tons.*	Exports. *Metric tons.*
1916	26,603	24,226
1917	26,125	17,376
1918	30,687	21,522
1919	33,558	39,712
1920	38,386	34,783
1921	40,351	36,426
1922	42,640	39,954
1923	45,575	42,545

The exports in 1923 consisted of the following varieties :

	Metric tons.
Rough Peruvian	3,514
Moderately Rough Peruvian	872
Mitafifi	8,794
Tanguis	21,394
Egyptian	8,502

In addition to these varieties, small quantities of Sakellaridis, Caravonica and Sea Island are produced.

Flax

Iraq.—Experiments have been carried out in Iraq by the Department of Agriculture to determine the suitability of the country for flax production. According to the

Report on the Administration of Iraq for the period April 1923–December 1924 [*Colonial No.* 13], the last two seasons' work has proved definitely that flax can be grown and prepared in the country of a quality which would be saleable at a good price in the United Kingdom. The Department is now in a position to give advice regarding the cultivation of flax and the most suitable varieties to grow. The development of a flax-growing industry is hindered by the absence of a mill to purchase the straw from the growers and by the fact that commercial bodies are not disposed to establish mills until they are assured of a regular supply. Any undertaking commencing flax operations in Iraq would have to incur considerable expense in stimulating the cultivation of the crop, and it would therefore be necessary for some sort of limited concession to be given. This question is under the consideration of the Government.

Paper-making Materials

Woods from the Ivory Coast.—In continuation of an investigation of certain woods from the Ivory Coast as possible materials for paper-making (see this BULLETIN, 1925, **23**, 367), a study has now been made of " Avodiré " wood (*Turræanthus africana*, F. Pellegrin) by Professor F. Heim de Balsac, in collaboration with M. Cercelet, G.-S. Dagand and R. Heim de Balsac, and the results have been published in *Bull. de l'Agence Gén. des Colonies* (1925, **18**, 520).

The wood contained 11·1 per cent. of moisture. On chemical analysis, it yielded 4·56 per cent. of ash, 0·80 per cent. of fats and waxes, 62·15 per cent. of cellulose and 32·49 per cent. of lignone (expressed in each case on the dry material).

On digestion with caustic soda solution of 5 per cent. strength for 8 hours under a pressure of 3 kilos., a light brownish-yellow pulp was obtained which bleached easily. The bleached pulp was dull white and the yield amounted to 37 per cent. of the dry wood. On microscopical examination, the pulp was found to consist almost entirely of cylindrical fibres which tapered regularly and had a wide lumen and thin walls; a few cells and fragments of vessels were also present. The fibres varied in length from 1 to 2 mm. (with an average of 1·5 mm.), and in diameter from 15 to 25μ (with an average of 20μ) and had a felting power (diameter: length) of 0·015. The pulp furnishes paper which is comparable in every respect with that obtained from the ordinary wood pulps of commerce.

Sisal Hemp

Ceylon.—In this BULLETIN (1924, **22**, 47) reference was made to the cultivation of Sisal hemp in Ceylon, and it was mentioned that the Agricultural Department are carrying on experiments at Anuradhapura, where a small extracting mill has been established. An account of the work at this Experiment Station has been given by F. A. Stockdale, C.B.E., M.A., Director of Agriculture, and G. Harbord, Divisional Agricultural Officer, in *Trop. Agric.* (*Ceylon*) (1925, **65**, 106).

Eighteen acres have now been planted with Sisal hemp, the plants being spaced 8 ft. × 6 ft., thus giving 908 plants per acre. An average of 44 leaves per plant has been harvested annually. The mature leaves had an average weight of 1·4 lb., an average height of 3 ft. 6 in., and gave a yield of 2·6 per cent. of dry fibre or 36·4 lb. per 1,000 leaves. The annual yield of fibre per acre was from 0·5 to 0·6 ton. The plants come into bearing during the fourth year; some poling begins during the fifth year and becomes fairly general during the sixth year. The loss of leaves can be prevented by cutting off the poles as soon as they appear. It is considered that the early poling is due to suckers having been used for planting. Mr. Harbord adds that data are not yet available as to the length of the cropping period, but he estimates it at four or possibly five years, with an average yield of fibre of ½ ton per acre per annum.

The cost of production of the fibre per ton has been worked out on a basis of a four-years' cropping period and an annual yield of ½ ton of fibre per acre. The details are as follows: cultivation, Rs.95·00; harvesting, Rs.93·75; extraction and drying, Rs.110·00; sorting and combing, Rs.22·40; baling, Rs.8·00; depreciation (at 10 per cent. on the value of the machinery and buildings), Rs.2·54; interest on capital (Rs.8,500) at 8 per cent., Rs.2·00; total, Rs.333·69. All these figures are based on minimum returns and may be reduced with further experience.

Sisal hemp from the Experiment Station has been sold in London at £40–45 per ton, equivalent to Rs.400–425 in Colombo. Sales have also been made in Colombo at Rs.400 per ton. On the basis of an annual yield of 44 leaves per plant, an income of Rs.143·82 per acre would be obtained whilst the crop is in bearing. An area of 3–4 acres would apparently furnish a livelihood to a village cultivator, and it is suggested that a trial scheme should be put forward for the consideration of the Government. Such an industry would be of great advantage for the dry zone and would help to solve the local unemployment problem.

Mozambique.—An article on Sisal growing in Mozambique has been contributed by C. de Mello Geraldes to *Rev. Bot. Appl. et d'Agric. Col.* (1925, **5**, 500). The cultivation was introduced into that country in 1904 by the Companhia do Borôr and has undergone great development, especially since 1911. A number of companies are now planting the crop and the industry is chiefly situated in the north of Mozambique, especially in the district of Quelimane and in the territories administered by the Mozambique Company. The quantities of fibre exported during recent years were as follows (in metric tons): 1918, 1,356; 1919, 1,761; 1920, 2,325; 1921, 3,769; 1922, 3,179.

The country has a hot climate and a variable rainfall. In Quelimane rain sometimes falls throughout the year, but the heaviest rains usually occur from November to May. The temperature, however, is fairly constant during the whole year; the maximum sometimes reaches 40° C. and the minimum 8° C., but the mean annual temperature varies in general from 23° C. to 27° C. according to the locality. The soil is argillaceous and, although poor in lime, gives good yields of fibre per acre. Information is given in the article regarding the different methods of cultivation and preparation of the fibre adopted by the different companies at work in the country.

The life of a sisal plantation in Mozambique is from 6 to 8 years, and the period during which leaves are cut from 3 to 5 years. The comparatively short life of the plant is attributed to the humidity of the climate and the richness of the soil, but this is compensated to some extent by the great development of the leaves, which sometimes attain a length of 2 metres. Some growers in Mozambique believe that the life of the plant can be prolonged by cutting out the pole, whilst others hold the opposite opinion. The author of the article considers it probable that this practice does enable a better yield of leaves to be obtained from the plant, but regards it as questionable whether the increased yield is sufficient to repay the expense of the extra work entailed.

Reference is made to the various types of extraction machinery employed in the different plantations and information is furnished as to their relative merits.

It is evident that Mozambique has now become an important centre of sisal production. Some types of fibre exported are of very good quality, whilst others, although of good quality, could be improved by more careful preparation.

MINERALS

Aluminium Sulphate

Canada.—In the *Fifth Annual Report of the Scientific and Industrial Research Council of Alberta* of 1924 the occurrence of aluminium sulphate in the Smoky River is described by John A. Allen (pp. 41–43). The valleys of the Little Smoky and Big Smoky Rivers are cut from 500 to 600 ft. below the adjoining plateau. Extensive "slumping" of the soft rocks has occurred along the sides of the valleys, some blocks being half a mile or more in length. According to F. H. McLearn, of the Dominion Geological Survey, the rocks cropping out along the sides of the valleys belong to the "Smoky Formation," the lower part of which corresponds to the Colorado group of the Upper Cretaceous. This part, or "lower shale," consists of clay slates and sandy clays.

At many points along the valley sides the shale surface has become encrusted with aluminium sulphate. In some places the deposit is comparatively heavy. The salt usually encrusts and cements angular pieces of rock, thus forming a breccia, but in no place in this breccia is it over 2 in. thick; so that, although the deposit is extensive, it is not present in economic quantity. The salt has been derived by the leaching by surface waters of the contained salts in the "lower shale." The sulphur of the sulphate is derived from the oxidation of pyrite and marcasite in the shales and sandstones overlying the "lower shale." The salt contains from 16·21 to 10·04 per cent. of alumina, and from 67·18 to 73·56 per cent. of sulphur trioxide.

The occurrence is considered important owing to the possibility of finding larger and workable deposits.

Asbestos

Cyprus.—A brief article on the asbestos deposits of Cyprus by C. L. Sagui appears in *Econ. Geol.* (1925, **20**; 371). The fibre produced by the well-known mines of the island is chrysotile of good quality but has an average length of only ¼ in. The chrysotile occurs as veinlets in serpentine and the fibres are perpendicular to the walls. The payable material is only about 30 to 40 ft. in thickness, for below this depth the fibres become harsher and finally merge into veins of compact material having no trace of fibres. The origin of the asbestos is discussed.

Bauxite

Ireland.—According to the *Third Annual Report on Mining and Quarrying in Northern Ireland*, 1925, the Irish bauxites have been used hitherto chiefly for the manufacture of aluminium sulphate and for making refractory bricks. Recently, at the branch at Magheramorne of the British Portland Cement Manufacturers, bauxite and chalk have been used under a French patent for the production of a quick-setting variety of aluminous cement. There is an abundant supply of chalk at Magheramorne and along the north-east coast, and several of the Antrim bauxites have been found to be suitable for making this cement.

Nyasaland.—A description of the recently discovered deposits of bauxite in the Mlanje Mountains of Nyasaland by F. Dixey, Government Geologist, has appeared in the *Mining Magazine* (Oct. 1925, p. 201). Bauxite was first recognised in 1924 by the Geological Survey in the Luchenya Plateau (spelt Lichenya throughout the report), and since then other deposits have been found on the Likabula or Chambe Plateau, on the Sombani and Little Ruo plateaux, in the Sombani Valley and in the Lower Ruo Valley. It will be probably found also on other platforms round the flanks of Manene Peak. The Luchenya deposit is the most important ; next in order come the Chambe, Sombani Valley and Lower Ruo Valley deposits. Of these only the first is accessible and might be worked in conjunction with the Luchenya deposit.

The Mlanje Mountains, which consist of orthoclase-hornblende-syenite, originally stood some 3,000 ft. above an ancient plain, which itself stood about 4,000 ft. above the present plain. They were traversed by broad flat-bottomed valleys that opened out upon the ancient plain. Subsequent earth movements caused the greater part of this plain to subside relative to the mountain mass, its inner remaining portion forming a margin of a series of elevated platforms around the flanks of the mountains. On these platforms or plateaux, and in the valleys mentioned above, occur what remains of the bauxite originally resulting from the weathering of the syenite of the mountains.

On the Luchenya Plateau the principal deposit covers an area of less than 2 sq. miles. It has been tested by eight trial shafts from 13 to 41 ft. deep, by eleven small adits and by a number of minor workings, by which it has been shown that the deposit is from 14 to 41 ft. thick. Even assuming the deposit to average only 7 ft. in thickness, 20,000,000 tons of bauxite are available.

At the surface the bauxite is in hard, platy, porous masses, that vary in colour from buff to brick red. Deeper down it is pale salmon-pink or pale brick-red in colour, and varies in form, being rubbly, or platy or compact-earthy. Sometimes a banded structure, due to variation in composition of the parent rock, is observable, and some veins of manganese a few inches thick traversing the bauxite have been noticed. An analysis of a composite sample of bauxite taken in six of the shafts, at a depth of 6 ft. gave the following percentage composition: alumina, 57·63; ferric oxide, 10·35; silica, 1·70; water, 29·92.

The deposit, which is on the west side of the Mlanje Mountains, is cut off by a 4,000-ft. precipitous scarp from the present plain, and the author suggests that the use of an aerial tramway would be the cheapest means of bringing down the bauxite to the lower level. The deposit is about 15 miles from Luchenza station on the railway to the port of Beira, which is 330 miles distant. Ample water power is available in the neighbourhood, for the Luchenya River and its tributaries rise on or near the plateau, and in a few miles there is a fall of over 3,000 ft.

From a consideration of other available bauxite deposits in East Africa the author considers the Luchenya deposit the only one capable of commercial development.

Cement Materials

New South Wales.—A useful summary of the resources of these minerals in New South Wales is given by L. J. Jones in *Bulletin No. 9 of the Department of Mines*, entitled "Limestone, Dolomite, Lime, and Hydraulic Cement."

From the information given, it is evident that the State has large resources of cement materials and its output of Portland cement is steadily increasing.

Chromium

South Africa.—In the Rustenburg District, Transvaal, there are at least three parallel chromite lodes running N.W.–S.E., about 1½ miles apart, the outcrops of which can be traced from the town of Rustenburg, N.W. for 60 miles. These deposits have been opened up in places over 20 miles apart. The lodes are from 7 to 40 ft. wide, and contain from 38 to 48 per cent. of chromic oxide

(Cr_2O_3). On one farm a face of pure chromi thick assayed 46 per cent. of chromic oxid railway line close by.

The chromite deposits of the above district frequently contain fairly consistent values up to 7 dwts. of the platinoid metals (*S. Afr. Eng. and Min. Journ.*, July 11, 1925, p. 539).

Australia.—The chromite deposits of New South Wales are described by H. G. Raggatt (*New South Wales Dept. Mines, Geol. Survey, Bull.* 13, 1925, p. 4).

All the deposits occur as segregations in ultra-basic rocks, chiefly peridotite and serpentine. There are three serpentine belts which have produced chromite. The most northerly one is the Gordonbrook belt, which contains two groups of lenses of chromite. The ore assays from 39·7 to 55·27 per cent. of chromic oxide. The probable amount of ore obtainable is estimated at 20,000 tons. This belt is undeveloped at present, owing to its being 21 miles by road to Copmanhurst, on the Clarence River. The Great Serpentine belt, south of the above, is traceable over a distance of 200 miles, with a general N. 20° W. strike. The main producing centres of this belt are Nundle, Attunga, Manilla, Barraba and Bingare. Farther south lies the Gundagai-Wallendbeen Serpentine belt. Chromite has been worked in the vicinity of Coolac and Gundagai since 1892. Several of the mines in 1894 and 1895 yielded 25,000 tons of high-grade ore, but the deposits have been worked intermittently since. In Wallendbeen the average content of chromic oxide in the samples is 47 per cent. The production in 1917 and 1918 was 127 and 256 tons respectively.

From 1882 to 1923, inclusive, New South Wales has produced 37,521 tons of chromite, value £102,845.

Coal

South Africa.—W. T. Wybergh's first volume on the *Coal Resources of Union of South Africa*, published in 1922, was referred to in this BULLETIN (1922, **20**, 532). The second volume, comprising the inland coalfields of Natal, has appeared recently (*Union of S. Africa Dept. Mines and Ind., Geol. Survey Mem.* 19, Vol. II, 1925).

In 1923 the Natal collieries produced 4,302,892 short tons, of value £1,697,817.

Klip River Coalfield.—The coal-bearing area is 53 miles in length and about 25 miles in width. The coal measures consist of shales, sandstones, grits and coal seams, with occasional thin beds of ironstone. There are two commercially valuable seams, known as the " top " and " bottom " seams, which are fairly persistent throughout the whole area. They are usually from 3 to 5 ft. thick (extremes 2 ft. and 10 ft.), and from 5 to 6 ft. apart (extremes a few inches and 50 ft.).

The evaporative power of the coals from the central area varies from 13·44 to 14·28. The gross reserves in seams over 2 ft. thick are estimated to be: proved, 443,202,000 short tons (6 ft. of coal); estimated, 777,345,000 tons (6 ft. 2 in. of coal); undetermined, 918,498,000 tons (3 ft. 5 in. of coal); total, 2,139,045,000 short tons. Most of the coal marketed is an excellent steam coal, well suited for shipping purposes. There are numerous sheets of dolerite in the area. In some instances the dolerite has affected the coal by reducing the volatile contents. Dykes are numerous and the coal associated with them is occasionally of no value, while in some areas they have converted the coal into anthracite.

Vryheid Coalfield.—This consists of a number of detached coal-bearing areas. The coal measures consist of clay shales, carbonaceous shales and workable coal seams interstratified with sandstones. There are four main coal seams known as the " Alfred," " Gus," " Dundas " and " Coking " seams, averaging 4 ft., 4 ft., 5½ ft. and 2½ ft. thick respectively. The Gus seam is the most important. The evaporative power of the coals from this field varies from 13·35 to 14·43. The proved reserves are 277,102,000 short tons, the estimated reserves 294,398,000, or total 571,500,000 short tons. A good deal of the coal is a high-grade coking coal.

Utrecht Coalfield.—There are three producing collieries in this field, two of which are of considerable importance. The coal measures consist of sandstone (largely predominating) and shales—the latter include some beds of oil shale. There are four principal seams near Paulpietersburg, identical with those of the Vryheid coalfield, which aggregate from 10 to 11 ft. of coal. The coal varies from semi-bituminous to bituminous, but the percentage of ash is very low, and some of the coals appear to be equal to the very best in the country. The evaporative power averages 13·62. Of the proved coal there are 94,098,000 tons; of estimated coal, 256,240,000 (both estimates being of coal containing over 16 per cent. of volatiles). Of the proved coal, 17,694,000 tons are contained in seams between 2 ft. and 3 ft. thick, and 76,394,000 tons in seams over 3 ft. thick. The total thickness of coal now worked in the two large collieries amounts to 7 ft. 3 in.

Somaliland Protectorate.—A seam of coal has been found in the bed and on both sides of the Hedhal Tug, the average thickness of which is 2 ft. 6 in., and the dip W. 5°. It occurs 3¼ miles up the tug in a tableland of sandstone overlaid by Eocene limestone. The outcrop has been traced for 100 yds. on one side of the tug, and for about 30 yds. on the other. According to samples analysed at the Imperial Institute, the coal is free-burning, with no tendency to coke, and in type and appearance is very similar to the coal of Udi colliery, Nigeria, although somewhat inferior to it in heating power. Every tug was to be examined in the cool season, which began in October last (*Mineral Possibilities of the Somaliland Protectorate*, by R. A. Farquharson, Government Geologist, pp. 6, 7, March 1925).

Australia.—*Bulletin No.* 6 on the Coal Resources of New South Wales has appeared recently (*New South Wales Dept. Mines, Geol. Survey*, 1925). The coalfields of New South Wales were described with some detail in the Imperial Institute Monograph *Coal* (1920, pp. 105–117), and, in the following notes, only more recent discoveries or developments are alluded to. All the coalfields mentioned are of Permian age.

The Curlewis coalfield is a northerly extension of the northern coalfield. The top seam, from 12 to 15 ft. thick, includes numerous bands; the middle seam is 5 ft. thick; and the bottom seam, consisting of 6 ft. of good coal, is at present the only one being worked.

The Douglas Park-Berrima field is a westerly extension of the southern coalfield. To the north, bores put down in the neighbourhood of Bargo, Douglas Park and Menangle proved the extension of the Bulli seam over a wide area, and considerably increased the tonnage of the available coal reserves.

Talbragar is an extension of the western portion of the Western coalfield, but the coal seams are variable in thickness and extent, and have a number of intercalated clay bands. Recent attempts to exploit this coal have not been commercially successful.

The isolated basin recently discovered at Coorabin has already been referred to in this BULLETIN (1922, **20**, 118). By borings and shafts coal has been proved to exist over a length of 5 miles and a width of 3 miles. The coal is of better quality in the southern than in the northern portion of the proved area. The coal appears to be intermediate between lignite and sub-bituminous coal. The calorific value is approximately 10,000 B.T.U.

During 1923 M. Morrison found that the Lower (Greta) Coal measures extend to Muswellbrook in two well-defined belts. Seven seams of coal have been proved in these measures by boring, and one seam at least, from 10 to 19 ft. in thickness, is being worked. The locality may become an important producing coalfield.

The area of proved coal measures of Permian age in New South Wales is approximately 1,200 sq. miles. The reserves of coal are estimated approximately at 20,000 million tons. Deducting one-third for loss in working, the reserves may be estimated conservatively at 12,000 million tons.

Cobalt

Australia.—Cobalt has recently been discovered on the dumps of two mines in the Cloncurry Mineral Field, Queensland. This makes the fifth discovery of cobalt in this field (*Chem. Eng. and Min. Review*, p. 341, June 1925).

The Queen Sally Cobalt Mine, Koolamarra, Cloncurry, has been reported on by E. C. Saint-Smith (*Queensland Govt. Min. Jour.*, p. 281, July 1925). The lode containing the cobalt strikes N.W. to S.E. and dips N.E. 60°. One shaft sunk on the lode to a depth of 32 ft. shows a little black oxide of cobalt in fractured quartzite. Partly altered kernels of cobalt arsenide (smaltite), associated with a notable amount of cobalt bloom (erythrite), occur through the lode from 4 ft. downwards, and are also showing in the shaft bottom, but the bulk of the ore is in the form of black oxide (asbolite). In the shaft bottom the good ore is 3 ft. wide, and the pitch of the ore-shoot is south-easterly.

The No. 2 shaft, 120 ft. S. of the last, is 50 ft. in depth, but the ore-seam was passed through at 22 ft. in depth. A cross-cut will be necessary to pick up the seam again. In both shafts the ore is frequently disposed along " floors " in the highly disrupted quartz-schist. About 5 tons of high-grade black oxide and 40 tons of seconds have been brought to the surface and await treatment. The ore already bagged is estimated to contain about 20 per cent. of metallic cobalt.

Copper

Canada.—A description of the Horne Mine, Rouyn Township, Quebec, is given by Lloyd J. Moore in the *Canadian Mining Journal* (Oct. 9, 1925, p. 943). The deposit at this mine was discovered near Lake Osisko in 1920, the cap of a lode about 60 ft. wide being uncovered by trenching. Samples assayed from 2 to 11 dwts. of gold per ton, with little or no copper. The Thomson-Chadbourne Syndicate, later the Noranda Mines, Ltd., took an option over the property in 1922. Since then development has been attended with remarkable success, the net value of the ore on the Horne property being conservatively estimated at $14,000,000. It is considered that the mine will be ready for production in about three years, but much depends upon the construction of the railway contemplated from O'Brien, on the Government Transcontinental Railway, to Lake Osisko.

It has been decided to concentrate the copper ore and to smelt the concentrate in reverberatory furnaces. A plant of capacity 500 tons per day, to cost $2,000,000, has been provided for. The ore contains on an average 9 dwts. of gold per ton, which is estimated to be enough to pay for smelting. Another $2,000,000 will be set aside for mining plant, development, the building of a town etc. In the last twelve months $700,000 has been spent on development. This included 21,000 ft. of diamond drilling, which resulted in the discovery of important ore-bodies at depth. Some of the ore-bodies met with at the surface have been proved to extend to a depth of 700 ft. No. 1 shaft has been sunk to 325 ft. in depth, almost entirely in ore; No. 2 shaft, to 146 ft. Lateral development amounts to 3,500 ft.

Of the several ore-bodies known, the "E" body has been exposed at the surface for 270 ft., with a maximum width of 36 ft. In a cross-cut at the 100-ft. level it is 70 ft. wide, and assays 10 per cent. of copper and 4 dwts. of gold per ton. With copper at 13 cents per lb. the average value is $30 per ton. Allowing $10 per ton for treatment, the value of the ore above the 100-ft. level has been estimated at over $5,000,000. Of the other ore-bodies the "A" has already been proved to contain a large tonnage of ore, whilst the "B" has been shown to be a potentially big producer, possibly the most extensive in the mine. The "C" ore-body is separated by a dolerite dyke from the "E" ore-body; its mineral contents are similar. Another ore-body on the Horne, described as a freak, was discovered at the 100-ft. level; it contains no copper, but is stated to have an average gold content of 44 dwts. across a width of 20 ft.

The Rouyn belt is a continuation east of the Kirkland Lake area, where the ores go to a considerable depth. Possibly the Quebec ores may be found similarly at a good depth, but much geological evidence is still wanting.

Gold

Tanganyika Territory.—According to the *Report of Tanganyika Territory for* 1924 (*Colonial No.* 11), there was active prospecting for gold in the Mwanza district recently, and much ground has been taken up. The Kilimafeza mine is to be equipped with a treatment plant, and the Sekenke mine was reopened, crushing being resumed. The alluvial area available for sluicing on the Lupa River goldfield proved rich and extensive; the export for 1924 was 6,805½ oz. According to later information (*Fin. Times*, Oct. 5, 1925) the main reef in the Wilnical Claims was cut at 102 ft. depth, its value being 45 dwts. per ton over 48 in. Several prospecting shafts were being sunk on the Kilimafeza mine; an adit is being driven to cut the reef in the Rohogo Hill Section, and in the New Claims, east of the Kilimafeza, the reef has already been cut in some trenches.

Union of South Africa.—According to the *South African Mining and Engineering Journal* (Sept. 5, 1925), hydraulic mining and concentrating plant have been erected to work an auriferous flat deposit lying in the shales on the east side of Mt. Anderson, above the Sabie, Transvaal. The deposit has been traced for a considerable distance in the foothills, and is in the form of a big channel. It contains limonite and a high percentage of manganese, as well as small particles of decomposed chert. The gold occurs free or occluded in cubic crystals of limonite (pseudomorphs ?).

The concentrating plant contains classifying apparatus and jigs, the very fine limonite crystals and free gold being caught on corduroy tables. The concentrate saved amounts to between 2½ and 3 per cent. of the whole, and assays about 15 dwts. of gold per ton. It will be crushed fine and cyanided, presumably after amalgamation. The single monitor is provided with a 1½-in. jet.

Canada.—A second edition of the report of the Ontario Bureau of Mines on the Kirkland Lake gold area of Northern Ontario, published in 1914, has been prepared by A. G. Burrows and P. E. Hopkins (*Ann. Rept. Ontario Bur. Mines*, **32**, pt. iv, 1923, pp. 1–51) and recently issued.

Many important developments have taken place in the area since the original report was issued, and the geology has been examined in detail.

Kirkland Lake, which is in Teck township, Larder Lake Mining division of the Timiskaming district, is four miles N.E. of Swastika, with which it is in railway communication. A number of gold claims were staked during the Cobalt boom year of 1906 in the Swastika area and on the ground right up to Kirkland Lake, but most of these were abandoned; the Swastika and Lucky Cross companies, however, continued operations and produced gold. Renewed interest in the district resulted in the discovery of the Wright-Hargreaves mine in 1911, gold occurring in quartz veinlets traversing reddish felspar-porphyry. The discovery followed of promising veins in the Burnside, Robbins (Sylvanite), Wright-Hargreaves, Oakes (Lake Shore), Teck-Hughes, Wettlaufer (Orr), Wood-McKane (Kirkland Lake) and Hunton mines. Several mines have been developed to the 1,000- and 1,100-ft. levels; in one, the Kirkland Lake Proprietary (1919) (formerly the Tough-Oakes-Burnside), the shaft has reached 1,600 ft., but a total depth of 2,000 ft. has been provided for. Most of these mines have treatment plants in operation, and hydro-electric power is supplied from Charleton and from Cobalt in sufficient quantity for the whole camp.

Kirkland Lake is now second in importance among the gold-production areas of Ontario. The area is part of a large mineralised region that extends from Matachewan in the south-west into Quebec in the east. In places in this larger area the old gold-bearing rocks are covered by deposits of newer formations (conglomerate, greywacke and slate of the cobalt series) not removed by erosion, which possibly may cover gold deposits. Also the character of the gold deposits varies greatly in different parts, but all are believed to be connected with acid intrusive rocks (granite, porphyry, syenite) which outcrop often in the area.

With the exception of small amounts of Glacial and Recent sands and gravels the whole of the Kirkland Lake rocks exposed are of Pre-Cambrian age of the Keewatin, Timiskaming and Post-Timiskaming (Algoman ?) series. A number of stocks and dykes of Algoman age cut through Timiskaming sediments. The intrusives, consisting of red and grey felspar-porphyry, red hornblende-syenite and black mica-lamprophyre, in order of age, have a general direction of a little north of east. Much faulting subsequently occurred in a direction roughly N.E. by E., and in the fractures produced were deposited the gold-bearing solutions representing the end-point of the intrusion. Other faulting before and after the deposition of the gold is observable. The ore is mainly red porphyry and syenite, but here and there the lamprophyre and the conglomerate of the sediments are also gold-bearing.

The main fracture-zone or ore channel so far referred to has been traced for $2\frac{1}{4}$ miles. It contains the chief mines of the area, which have been mentioned above.

Another zone of similar strike lies about three-quarters of a mile south, and on it are the Montreal, Ontario, Hunton, Honer and Canadian Kirkland mines. On another zone about 2 miles north of Kirkland Lake, and known as the Goodfish Lake area, are a number of other mines, including the Goodfish, La Belle Kirkland and Fidelity.

The main fracture zone being mainly in low ground or under the bed of Kirkland Lake was difficult to prospect, so much of the earlier work was done on parallel or subsidiary and narrower veins. The main fracture was found to reach 40 ft. in thickness in places, but generally is from 5 to 15 ft. thick. The gangue of the ore consists of varying proportions of quartz with fractured porphyry, etc. Indications of the replacement nature of the ore are often seen. Various carbonates and chlorite are present also. Other minerals include pyrite, chalcopyrite, galena, blende, molybdenite and graphite. In addition there are various tellurides, the chief of which is altaite (PbTe), the others being calaverite ($AuTe_2$), kalgoorlite (a telluride of gold, silver and mercury), coloradoite (a mercury telluride), petzite (a silver telluride) and melonite ($NiTe_3$).

According to the technical press, bromocyanide treatment on the Wright-Hargreaves ore is being used for the recovery of gold from the tellurides, results indicating an increased extraction value of $1 per ton.

The report contains a large-scale geological map of the area, photographs of the locality and of the rocks, photomicrographs of rocks, mine plans, and diagrams of the methods of ore-treatment employed. The raw ore is cyanided, continuous agitation and counter-current decantation being employed.

The results of an examination of the Groundhog area, Ontario, made by E. W. Todd in 1923, are given in Part VI of the 33*rd Annual Report of the Ontario Department of Mines*, 1924. The area is 140 miles west of Sudbury. Although known to be auriferous since 1900, little attention has been given to it until recently, when a large number of claims were staked for gold. So far only a limited amount of surface work has been done on the Gosselin Claims.

The gold is found in mineralised quartz veins, which are numerous in the Keewatin rocks in all parts of the area. As the result of much strain fracturing has occurred, which has made possible the admission of mineral-bearing solutions. In places these rocks have been intruded by granite and felspar-porphyry, probably Algoman in age, and possibly economic gold deposits will be found. The report suggests that prospectors should pay attention to the Keewatin rocks bordering the felspar-porphyry.

An analysis of the felspar-porphyry found in the Penhorwood and Reeves districts shows it to be almost identical with that found at Timmins, Ontario, whilst its appearance and microscopical characters resemble those of the Algoman porphyry occurring at Porcupine and other districts.

A discovery of gold was made in the autumn of 1924 at Beardmore, Ontario, which is 130 miles from Port Arthur on the Canadian Pacific Railway main line. Work was not begun until June 1925. A description of the occurrence has been given in *Canadian Mining Journal* (Sept. 4, 1925, p. 839) by A. G. Burrows, Provincial Geologist. The general geology is shown on map No. 1836 of the Canadian Geological Survey.

The predominant rocks are schists, striking N. 70° to 80° E., having a nearly vertical dip, partly of igneous and partly of sedimentary origin. The former are similar to rocks ordinarily called Keewatin and are assumed to be of that age ; they consist largely of fine-grained basalt, now altered to chlorite schist. With these lavas are some altered basic dykes. The sedimentary schists are of greywacke and slate, which are similar to altered sediments of the Timiskaming Series, but no relation to the Keewatin lavas was noticed. Dolerite (" diabase ") dykes and sills of pre-Cambrian age occur in places, in one place a sill overlying Keewatin schist at 45° and at another place almost horizontally.

No acid intrusive rocks such as granite or porphyry were seen in the district.

The gold occurs mainly in quartzose veins which traverse the schists, but its origin has not been settled. Accessory minerals include arsenopyrite, chalcopyrite, pyrite, with a little pyrrhotite and magnetite. The area is so largely covered by drift that to prospect it properly will take some time. A number of claims have been staked, the principal groups of which are the Powers-Silams and the Mackenzie, but as only a small amount of work so far has been done upon them it is early yet to draw any conclusions.

Gold was found in the Larder Lake district of Ontario in 1906. Mining had been carried on generally in a desultory way until about 1920, when important developments took place on the Costello vein, which was discovered in 1914 at Pancake Lake, 1½ miles north of Larder village. A number of different gold deposits have been also found in the same neighbourhood. All these have been described in an article, " The Costello Gold Deposit at Pancake Lake," by Percy E. Hopkins (*Can. Min. Journ.*, June 19, 1925, p. 601).

The Costello vein has been developed mainly by two companies, the Canadian Associated Goldfields and the Crown Reserve, which work adjoining claims on the south and north, respectively. It is composed of reddish tuffs, intruded by quartz-syenite and impregnated by quartz, pyrite and arsenopyrite. The arsenopyrite is the characteristic mineral of the deposit as it is of many other veins in the vicinity. The vein has been proved for over 2,000 ft. in length by driving and by diamond drilling, and the finding of its further extension seems likely.

Adjoining the southern edge of some Keewatin basalt, which has been intruded by quartz-porphyry and altered in places to " ferro-dolomite," is a narrow ore channel of tufaceous greywacke and black slates (Timiskamian ?). These contain some iron formation and generally strike N. 65° E. and dip 65° S. 25° E. They consist of felspar, biotite, quartz, calcite, chlorite, sericite, pyrite, magnetite and graphite, all more or less banded. The Costello vein is in these carbonate tuffs, following their strike. The ore is reddish due to the presence of ferric oxide and ferrous carbonate. The walls, especially the hanging wall, have been replaced by quartz, calcite, reddish felspar, ferric oxide, etc. Nearly always closely following the footwall is a fault known as the Costello Graphite Fault, which is 6 to 36 in. thick, and has been traced for nearly ¾ mile. It is filled mostly with graphitic material, and usually contains from 1 to 4 dwts. of gold per ton.

The holding of the Associated Goldfields amounts to 65 acres. A vertical shaft is being sunk to a depth of 1,000 ft. almost entirely in the footwall country, and at the time of writing had reached 800 ft. The vein has been driven on at different levels, for 500 ft. at the 360-ft. level, where it is narrow, but widens to 22 ft. at the east end. The equipment of the mine with a treatment plant is contemplated.

The Crown Reserve Company's shaft, 360 ft. away from the other shaft, is vertical and in the footwall; it had reached a depth of 570 ft. In sinking, besides the Costello or No. 1 vein being cut, two other parallel veins, Nos. 2 and 3, were sunk through at horizontal distances of 75 and 100 ft. from the Costello vein. This vein varies from 5 to 50 ft. in thickness, of which all is not necessarily ore; for example, in one cross-cut 12 ft. of ore averages 8 dwts. of gold per ton, whilst the adjoining 12 to 15 ft. averages between 3 and 4 dwts. At a point 1,000 ft. east from the shaft, diamond drilling showed 11 ft. of ore assaying 6·8 dwts. per ton. Vein No. 2 has been driven on at different levels. On the 300-ft. level for 125 ft. in length it averaged 7 ft. in width with a gold content of 5·3 dwts. per ton. The No. 3 vein also cut in the cross-cut at the 550 ft. level is there very irregular.

A number of other claims are being developed in the neighbourhood.

New Zealand.—The Kawarau River some sixty years ago was well known for the large amount of alluvial gold recovered from its banks whenever the water was low. The river falls only 4 or 5 ft. in winter, but the lower the fall the better was the gold recovery. Hitherto dredging operations have been impossible owing to the swiftness of the river. Recently, however, a company was formed to carry on dredging on a large scale. For this purpose the river is being dammed at its principal source, at Lake Wakatipu. According to *Chemical Engineering and Mining Review* (May 5, 1925) it is expected that the dam, which will be about 400 ft. long, will be finished by June 1926. It is anticipated that the scheme will lower the river considerably.

Lithium

Canada.—According to *Canadian Chemistry and Metallurgy*, September 1925, p. 200, an English syndicate has recently carried out much development work on a deposit containing lepidolite, spodumene and petalite occurring near Lamprey Falls on the Winnipeg River of Manitoba.

The ore is quarried from an ore-body 60 ft. wide, and is conveyed by a railway to the river, whence it goes by barge to the railway at Point du Bois, 7 miles distant. The lepidolite, which is stated to contain 5 per cent. of lithium, is finally shipped to England for treatment.

Mica

Canada.—According to a Reuter message (*Min. Journ.*, Aug. 22, 1925, p. 665), a large deposit of mica has been opened up at North Hastings, Ontario. Crystals weighing up to 1 ton each have been found and a cutting factory is being opened.

Monazite

Union of South Africa.—This mineral has been recently located in the Bushveld area of the Transvaal in certain lodes in quartz and granite in the Red Granite formation. According to the *South African Mining and Engineering Journal* (Aug. 29, 1925, p. 725), the monazite lodes are intimately associated with deposits of arsenical pyrites and gold ore, the latter carrying up to 15 dwts. of gold per ton. At present, no estimate can be made regarding the quantity of monazite likely to be recoverable.

Nickel

Australia.—The copper-nickel ore deposits of the Dundas Mineral Field of Tasmania are described by A. McIntosh Reid, Government Geologist (*Tasmania Dept. Mines, Geol. Survey, Bull.* 36, 1925).

The North Dundas copper-nickel field is midway between Zeehan (silver-lead) and Renison Bell (tin), which are 10 miles apart. The nickel-bearing country is 6 miles long and ½ mile wide, or 3 sq. miles in extent. The sedimentary rocks and associated tuffs belong to the Dundas series of the Cambro-Ordovician. The nickel ore is essentially a mixture of pyrrhotite, pentlandite and chalcopyrite in small crystalline grains. All the important shoots of ore are associated with pyroxenite and peridotite. Accessory minerals are pyrite, marcasite, galena and blende. Millerite, niccolite and zaratite are occasionally found.

The copper-nickel ore deposits have hitherto been explored to a depth which little exceeds 100 ft., at which depth the metallic minerals give place wholly, or in part, to white opaque quartz. The mining of the copper-nickel ores cannot be regarded yet as an established industry, but developments show such encouraging results that preparations are now being made for their exploitation on a commercial scale.

On the property of the Dundas-Cuni Mining Co., the ore occurs at the contact of pyroxenite and slate, and in places small offset deposits of lenticular shape are found wholly contained in slate. The ore-shoot in one shaft is 90 ft. long, at a depth of 75 ft. (bottom of mine). Analyses of bulk samples show from 6 to 11·72 per cent. of nickel, and from 2·9 to 7·58 per cent. of copper. The width varies from 6 in. to 5 ft. and averages 3 ft. It is proposed to explore the ore-bodies in depth by boring, and, if the results prove satisfactory, the south shaft will be developed to a depth of 150 ft., and a small blast-furnace will be erected to convert the ore into a copper-nickel-iron matte.

At the Melbourne Copper-Nickel mine, the ore is similar to the last. There are two known ore-shoots, one 60 and the other 80 ft. in length. The width varies from 6 in. to 10 ft., and the rich ore has been followed to a depth of 122 ft. The ore occurs in lenticular masses which dip E. 53° and pitch S. 52°. The production has amounted to 2,849 tons of ore, the bulk of which contained 10·4 per cent. of nickel and 5·2 per cent. of copper. The reserves are estimated at from 1,000 to 1,500 tons of similar grade. There is stacked ready for shipment 200 tons of high-grade ore.

Besides the above in this area, there are several prospects containing nickel ore the values of which are unknown at present.

Oil Shales and Petroleum

Australia.—Dr. Wade in a " Report on Petroleum Investigations made in New South Wales " (Melbourne : Government Printer, 1925), gives an account of the kerosene shale deposits with special reference to the Wolgan Valley Works.

According to John Fell, managing director of the Commonwealth Oil Corporation, the thickness of the kerosene shale in the Wolgan Valley averages 20 in. (extremes 14 in. and 50 in.), and the yield of crude oil per ton of shale averages 101½ gals. in actual distilling. The cost of retorting is stated to be extremely low, but mining to-day costs 30*s.* per ton of shale as compared with 12*s.* 4*d.* in pre-war days, so that it costs more than £3 to produce a ton of crude oil. If the cost of production could be brought down to, say, £1 per ton of shale or £2 per ton of crude oil, the industry would become self-supporting and profitable.

Dr. Wade points out that the mine and works in Wolgan Valley are in a deep, narrow and unfertile gorge, and the narrow-gauge railway connected with the works has a fall of 2,000 ft. in less than 40 miles from Newnes ; hence transportation is expensive. On the other hand, the Capertree Valley, a few miles to the north, is broad and fertile and well farmed ; moreover, the shale is thicker, the average thickness, according to Cambage, being 3–4 ft. over 4,000 ft. A railway here would help the farmer, and the fall to Windsor on the Richmond branch line is only 1,065 ft. in 78 miles.

The oil shales of the Mersey Valley, near Latrobe, Tasmania, have been tested by nineteen bores, and a seam from 6 to 7 ft. thick has been proved in an area of 300 acres, or, say, 2,000,000 tons of shale. A tunnel is being driven to work the shale close to the plant site, and a branch line is being laid to connect the plant site with the main railway line. A single unit plant has been designed, and tenders have been called for the supply and delivery of this plant, which will include a retort and oil tank with capacities of 120 tons and 55,000 gals. respectively. The oil shale yields 40·7 gals. to the ton, the sulphur content being 1·94 per cent. (the Admiralty allowance is 3 per cent.). The heat value of the oil is 15,053 B.T.U. per lb. (*Age*, Aug. 28 and Sept. 1, 1925).

New Zealand.—The Tarata bore, near New Plymouth, Taranaki, New Zealand, is down 1,510 ft. into good shale. A little gas has been encountered, and the somewhat disappointing yield of oil to date shows signs of improvement. The Moturoa bore is down 1,100 ft. into promising shale. The show of oil is highly satisfactory. A considerable volume of gas has been met with and the boring operations are within a few feet of the depth at which the predicted main oil reservoir should lie (*Chem. and Eng. Min. Rev.*, June 1925, p. 348).

Platinum

Union of South Africa.—A description of the recent discovery of platinum-bearing norite made by David Draper on the farm Elandsfontein (374), some 25 miles N.W. of Pretoria, Transvaal, is given in the *S.A. Mining and Engineering Journal* (Oct. 3, 1925, p. 113). The farm has an area of 1,964 English acres, is rectangular in shape and about 4 miles in length from east to west. A line of decomposed norite identical with the platiniferous bed at Lydenburg was found, and assays gave an average of 2 dwts. of platinum metals per ton. The discovery has been confirmed by Messrs. Hall and Wagner of the Geological Survey, who state that the ore-body or reef found is similar to the Main or Merensky Reef at Lydenburg. The Rustenburg–Pretoria Railway completely traverses the Elandsfontein farm from east to west, and the "Merensky Reef" was discovered about 700 ft. south of it. Actually 4 miles of outcrop were disclosed, and the reef is being opened up also beyond the farm boundaries on the Schietfontein and the De Kroon.

The reef, which is of low grade and dips to the north at a low angle, is being tested by a small pug mill or edge runner, the pulp being passed over corduroy strakes, to examine the concentrates produced. Development by means of a shaft is proceeding. It is claimed that the reef could be cheaply mined owing to its great width and to its low silica content, which indicates a soft ore.

Potash

Palestine.—The possibility of utilising the highly concentrated saline waters of the Dead Sea as a source of potash has been investigated recently. A summary of the results of practical trials carried out in Palestine and London and the conclusions arrived at are given in *Production of Minerals from the Waters of the Dead Sea* (reports relating to preliminary investigations, 1923–5), published, on behalf of the Government of Palestine, by the Crown Agents for the Colonies.

It is estimated that the Dead Sea contains the following quantities (in million metric tons) of the more important constituents: potassium chloride, 2,000; magnesium chloride, 22,000; sodium chloride, 11,900; calcium chloride, 6,000; magnesium bromide, 980.

The London Committee considered that from the technical standpoint (as apart from the commercial) no insuperable difficulties were likely to be encountered in extracting potash in quantities of the order of 100,000 tons of potassium chloride per annum, and that practically unlimited quantities of common salt and magnesium chloride could be produced.

In view of the fluctuations of the potash market and the unknown future conditions regarding potash production in Europe, the Committee could not forecast the commercial prospects of potash recovery from the Dead Sea, but expressed the opinion that transport costs would absorb a considerable proportion of the market value of potassium chloride from that source, and would, to a large extent, render the large quantities of common salt and magnesium chloride unsaleable.

Precious Stones—Diamonds

Tanganyika.—It was reported in *East Africa* (July 16, 1925) that diamonds had been found midway between Lakes Victoria and Kivu. Subsequently it was stated (*Times*, Aug. 17, 1925, and Sept. 12 and 21, 1925) that a pipe similar to those of Kimberley had been found at Mwanza, in spite of this being situated in granite country. The diamonds seem to have been found over a considerable area, and the yield has so far been about 35 carats per 100 loads. The largest stone obtained weighed 8 carats.

Radio-active Ores

South Australia.—The reopening of the Olary and Mount Painter deposits has already been noted in this BULLETIN (1924, **22**, 380), and further progress is now reported in *Industrial Australian and Mining Standard*, July 23, 1925, p. 112.

It is stated that a rich shoot of ore has been located and proved to a depth of 50 ft. and other prospecting work has given promising indications.

A treatment plant capable of dealing with 10 tons of concentrates per week is being erected at Dry Creek about 6 miles north of Adelaide.

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Mica. By A. H. A. Robinson. *Canadian Official Mining News Letter No.* 64. Foolscap. Pp. 2 (mimeographed). (London: Office of the H.C. for Canada, 1925.)

The Marketing of Mica. *S. Afr. Journ. Indust.* (1925, **8**, 575–577).

Les Gisements de Phlogopite de la Région de Fort-Dauphin, Madagascar. By L. Dumas. *Bull. des Mines de Madagascar* (No. 31, July 1925, pp. 107–111).

The Preparation and Comparative Performance of Base-exchange Water-softening Materials. [Includes the preparation of natural glauconite for this purpose.] By E. B. Higgins and J. P. O'Callaghan. *Chem. and Indust.* (1925, **44**, 882–885).

Recent Experience with Ducil [Synthetic alumino-silicate] as a Water-softening Material. By T. P. Hilditch and H. J. Wheaton. *loc. cit.* (pp. 885–887).

NOTICES OF RECENT LITERATURE

THE MAKING OF INDIA. By A. Yusuf Ali, C.B.E., M.A., LL.M., F.R.S.L., etc. Pp. xvi + 318, 8¾ × 5¾. (London: A. & C. Black, Ltd., 1925.) Price 10*s.* 6*d.*

The scope of this book may be judged from the subtitle, which describes it as follows: "A brief history of the different elements, geographical, ethnical, material, moral and political, that went to the building up of the Indian people, with an account of the foundation, consolidation and progress of British rule in India."

Much history has been involved in the making of

India and to set this forth in any detail would fill many volumes. But the author has endeavoured to show, in one small volume, how the history of India is connected with the world's history, and to do this in the space at his disposal he has had to state facts as concisely as possible. The result is, to quote the preface, " a sketch for what may emerge as a larger scheme in the future."

The book is divided into twenty-five chapters, the first two of which are descriptive of the country and of the people, whilst the two following are devoted to the influence of the Hindu and Buddhist religions. The remaining chapters contain a record of historical events, from the time of the Persian conquest of the Punjab in the fifth century B.C., down to the present day. Each chapter consists of paragraphs of about half-a-page in length with headings in bold type, and each paragraph deals with a particular historical fact. This arrangement makes the book rather scrappy to read, but it does facilitate reference, and this should appeal to the student. Throughout the book prominence has been given to social, economic and religious factors which, as the author points out, are often under-rated in historical works. The following sentence concludes a survey of the present position (June 1925) : " The salvation of India will depend on her own powers of internal consolidation, and co-operation with the forces making for harmony, law, order and progress," and with this conclusion few will disagree.

Appended to the volume are (1) a table showing the principal stages in the growth of the British Empire in India ; (2) a list of books for further study, and (3) a chronological table. There is also a good index and several outline maps.

THE ENGLISH FACTORIES IN INDIA, 1665–1667. By Sir William Foster, C.I.E. Pp. vi + 354, 9 × 6. (Oxford : The Clarendon Press, 1925.) Price 18*s*.

This book is one of a series designed to render available to the general reader historical information gathered from Records contained in various Government archives and not otherwise easily accessible. The period recorded is that of the Second Dutch War. Much of the information is presented by means of extracts from contemporary correspondence between the mercantile agents, or factors of the East India Company at their agencies or factories in India and their directors in England. Abundant reference is naturally made to the effects of the war on trade and the steps taken to withstand anticipated attacks on the factories by the Dutch.

Apart from indirect losses due to restriction of shipping, losses by sea due to direct enemy action appear to have been negligible, one ship alone having been captured. In territorial waters the Indian authorities usually appear to have been able to enforce neutrality. On land, however, the factories on the Malabar Coast suffered somewhat severely.

An important feature of the book is the information given as to the early history of Bombay—its acquisition from the Portuguese, its early administration, and the steps taken to fortify it against the Dutch. A view-plan of the defensive works of 1665 forms the frontispiece of the book.

Many other topics of interest are contained in the volume and much that is new. The author has succeeded in putting before the reader a very graphic picture of the difficulties and dangers besetting the English in India during this very critical period. An extensive list of references to India Office documents is provided.

MALAYAN TRADE ANNUAL, 1925. With a Foreword by F. George Penny, M.P. Edited by Philip C. Coote. Pp. 123, 8½ × 5½. (London: Sampson Low, Marston & Co., Ltd.) Price 3*s.* 6*d.*

As its title indicates, this handbook is designed primarily for commercial readers interested in Malaya. As a useful compendium of information it can, however, be recommended to general readers who desire a short, reliable account of modern conditions in the country.

SOUTH AFRICA: PEOPLE, PLACES AND PROBLEMS. By William Harbutt Dawson. Pp. xi + 448, 8¾ × 5¾. (London: Longmans, Green & Co., 1925.) Price 16*s.*

In this book the author has compressed information on almost every aspect of South Africa, its peoples and the questions confronting them. Geography, history, ethnology, social and political life, agriculture, white settlement and the requisite type of settler, all come in for consideration.

The main theme of the book is the racial question, on the solution of which the future of South Africa depends. A chapter is devoted to the relationship between the British and the Dutch. The author considers that there is still room for improvement in this matter, and earnestly appeals for a deeper sympathy between the two peoples. The Asiatic question is also discussed. Even more important are the questions relating to the native population. This subject is discussed in some half-dozen chapters dealing with native character, the colour bar, labour and wages, justice, education and the policy of segregation. While admitting the controversial nature of the question, the author deplores the prejudice shown by the white workman against unskilled labour, or "Kaffir-work." He concludes that only by a partial and gradual method of segregation according to which the native would be encouraged and even assisted to devote his time to agricultural and pastoral pursuits on extended reservations, and also by the changing of the country's basis of economic life by gradual stages to white labour, can European paramountcy and civilisation be permanently assured. The author further makes the bold suggestion that the natives might be granted recognition as an independent political community with a "National Council," subordinate to the existing Legislature, thus gaining experience in political responsibilities preparatory to a larger enfranchisement in time to come.

The book is provided with thirty-five photographic illustrations. The addition of a map would have been an advantage.

A BIBLIOGRAPHY OF SIERRA LEONE. Preceded by an Essay on the Origin, Character and Peoples of the Colony and Protectorate. By H. C. Luke, B.Litt., M.A., Colonial Secretary of Sierra Leone. Pp. 230, 7¼ × 5. Second enlarged edition. (Oxford : University Press ; London : Humphrey Milford, 1925.) Price 8*s*. 6*d*.

The scope of this book is clearly indicated in its title. The bibliography is arranged under the following sections : General Literature, including economic references ; Native Languages ; Colonial Law and Ordinances ; Articles in Journals of Societies, etc. ; Periodical Publications ; State and Parliamentary Papers ; and Maps. In the case of the more interesting of the early references, notes and extracts are given. The books in the various sections and sub-divisions are arranged chronologically, and reference to any particular subject is facilitated by a full subject index. There is also an author index.

HANDBOOK OF BRITISH HONDURAS. Compiled by M. S. Metzgen and H. E. C. Cain, under the direction of Sir Eyre Hutson, K.C.M.G. Pp. 460, 8¼ × 5¼. (London : The West India Committee, 1925.) Price 5*s*.

This useful volume, compiled by two officers of the Colonial Government and issued under its authority, follows the general lines of such works and deals systematically with the history, development and resources of the country. British Honduras is one of the smaller units of the Empire, in point of population as well as size—the whole area is only about 8,600 square miles—but it presents many interesting features, including its geographical position as a neighbour of the Central American republics. Several distinct races make up the population, which is estimated at less than 50,000. The forests are the chief natural asset, but their exploitation and the development of the Colony in general are hindered by the shortage of labour.

HANDBOOK OF WESTERN SAMOA. Pp. 174, 7 × 4¾. (Wellington, N.Z. : Government Printer, 1925.) Price 5*s.*

One of the most interesting of the territories transferred from German to British rule under the Treaty of Versailles is that known as Western Samoa, the mandate for which was accepted by the Dominion of New Zealand. The present handbook has been compiled and published under the authority of the Administration, and is "designed to give in popular form concise and accurate information concerning the Territory, its people and affairs." The reader will find in it a comprehensive summary of the history, ethnology, fauna and flora, climatic and physical features, and general character of the islands, as well as information of a practical kind for the assistance of traders and tourists. It is noteworthy that every effort is made to exclude undesirable immigrants from Western Samoa, and that, on the other hand, no actual resident is permitted to leave the Territory until all taxes and debts owing to the Administration have been paid.

The book, which is excellently printed and illustrated, contains two maps and a copious bibliography.

L'ILE DE LA RÉUNION. By R. Barquissau, H. Foucque and H. Jacob de Cordemoy. Pp. 285, 10 × 6½, with 2 maps. (Paris : Librairie Emile Larose, 1925.) Price Fr. 15.

This is the second edition of an authoritative work on Réunion, one of the oldest and most interesting of the French possessions in the Tropics. The authors give a mass of information on the history, social and intellectual culture, physical features, and economic development of the Colony, supplemented by an excellent bibliography as well as a number of photographs, illustrating the picturesque scenery of the island and other objects of interest. The volume is not a mere handbook, but a literary production which is well worth perusal.

Crop Production and Soil Management. By Joseph F. Cox, B.S.A. Pp. xxx + 516, 8¼ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925.) Price 13*s*. *6d.*

This volume, by the Professor of Farm Crops at Michigan Agricultural College, is intended as a handbook for students of crop production and soil-management problems, whether they are enrolled in a school or college, or occupied in farming work. For purposes of systematic study and ready use, the book is divided into two parts. In Part I are included chapters dealing with the various operations which the farmer performs in growing crops and maintaining fertility, while in Part II consideration is given to the operation of growing specific crops.

The opening paragraph of the book enumerates the essentials of successful farming in words that are worth quoting: "1. Grow crops adapted to your soil and climate; 2. Plant good seed of the highest yielding, best-adapted varieties; 3. Select seed to improve yield and quality; 4. Maintain or improve fertility; 5. Prepare seed beds efficiently; 6. Cultivate effectively and economically; 7. Harvest and store crops properly; 8. Control plant diseases, insect pests and noxious weeds; and 9. Produce a high-quality crop for best market demand." The author then proceeds to explain how these operations can best be carried out. Similarly, at the beginning of each account of the separate crops, the practices followed by the most successful growers are succinctly stated, before dealing with the subject in detail. This necessarily involves frequent repetition, but the method cannot fail to impress on the student the fundamental importance of the principles underlying successful farming.

Soil Characteristics: A Field and Laboratory Guide. By Paul Emerson, Ph.D. Pp. x + 222, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 12*s*. *6d.*

This book, written by the Associate Professor of Soils, Iowa State College, is intended to serve as a guide for the investigator, the instructor and the student, and deals with the determination of the physical, chemical and biological characteristics of soils. It is divided into four sections, in the first of which the general principles of soil classification are set out, followed by detailed instructions for the sampling of soils and their mechanical analysis. In the latter connection, only the subsidence method is described, none of the elutriation methods, which would be likely to give better results in the hands of a student, being mentioned. The second section, on soil physics, gives an account of the methods of determining the various physical properties of soils. The third section, on soil fertility, which is much the longest, deals with the chemical methods of determining the common elements and their various compounds met with in soils and fertilisers. Two schemes for complete soil analysis are given, one by fusion with sodium carbonate to determine the total amounts of all the elements present, and the second by digestion with strong acid, in which case " an indication is secured that at some future time the elements may become available." No mention is made of the well-known Dyer method, or any of the modifications for determining the immediately available plant food.

The fourth section of the book treats of soil microbiology and gives a good account of the various forms of microscopic life occurring in soils, including bacteria, protozoa and fungi. Directions are given for determining the numbers of the different forms and the results of their activity, such as oxidation of ammonia and of sulphur.

To each section is appended a list of references, mainly to publications issued in the United States. The author explains that he has restricted the references in this manner as American works are more readily available than foreign publications to students in American Institutions. This, however, reduces the value of the work to English readers, although, in most other respects, it is a useful and practical textbook.

THE HERITAGE OF COTTON: THE FIBRE OF TWO WORLDS AND MANY AGES. By M. D. C. Crawford. Pp. xix + 244, 9½ × 6½. (New York and London: G. P. Putnam's Sons, 1924.) Price 21*s.*

This work tells the story of cotton and the part it has played in the artistic, commercial and economic progress of the world. In the forefront of the book is given a list of the principal events in the history of cotton in the form of a chronological table.

No attempt is made to deal with the technical aspects of cotton cultivation and manufacture, but the aim has been "to present the story of the cotton fibre as a human drama—a drama that is by no means in its last act, but merely passing through one of its scenes." " If," says the author, " I may through these pages induce men to look again upon cotton as one of the subtlest mediums of art; if in some measure I may direct the thoughts of manufacturers and labourers to a better understanding of the psychological value of interest in work, I shall be amply repaid for my efforts."

The different chapters of the book deal with primitive culture; primitive technique; the New World; Peru; India; Europe; England; the eighteenth century—the age of the machine; cotton in the Colonies; the machine age in the United States and the growth of the cotton plantation; mill building in New England; the South; and research. The concluding chapter refers briefly to the position of the industry in the chief countries of cotton production and manufacture, and deals with such questions as the more general use of labour-saving devices, the marketing of cotton and the gambling in futures, land ownership, and labour supply and organisation.

The book, although exhibiting a tendency to a certain extravagance of expression, is eminently readable and contains a number of interesting illustrations.

COFFEE. A Monograph of the Economic Species of the Genus *Coffea*, L. By Ralph Holt Cheney, M.A., M.S., Sc.D. (Harvard). Pp. xvii + 244, 9¼ × 6¼. (New York: University Press, 1925.)

In spite of the great importance of coffee, there has not hitherto been a comprehensive study published of all the species of economic value. The present work, therefore, fills a distinct gap in the literature of the subject. The treatment presented by the author is an endeavour to include the systematic economic and cultural data which are indispensable to modern economic studies. Part I is a scientific discussion of the botany of coffee, including a key for the identification of economic species and an account of such species and their varieties in the two sections *Eucoffea* and *Lachnostoma*. A bibliography is given, including economic and cultural references, of each species and it would have been useful if all these numerous scattered lists had been collected together in the book. Part II is an economic discussion of coffee, including production and consumption data, types, preparation, and facts concerning the chemistry and the past and present adulteration of coffee. In concluding this part, a summary is given of other caffeine-yielding plants, their distribution and use. There are two appendixes, comprising respectively a philological discussion of coffee (including a new theory regarding the derivation of the word coffee), and a historical account of coffee-houses in the various countries. The work includes 84 excellent illustrations, and a chronological chart showing the use of coffee as a beverage throughout the world.

RICE: ITS CULTIVATION AND PREPARATION. By Charles E. Douglas, M.I.Mech.E. *Pitman's Common Commodities and Industries.* Pp. ix + 147, 7 × 4¾. (London: Sir Isaac Pitman & Sons, Ltd.). Price 3s.

In this little book the author has succeeded in compiling a very readable account of rice in all its various aspects. Commencing with the history of rice and ceremonies concerning it, he rapidly reviews the botanical and physical characteristics of the grain, its production and distribution, methods of cultivation, seed selection, sowing, transplanting, weeding and harvesting, and the problems of transport and supply. A short account is given of the native methods of preparing rice for food and then follows what will prove to the specialist the most valuable section of the book, a description of mechanical milling and preparation of rice in bulk. On these subjects the author, from his association with a well-known firm of rice machinery makers, obviously writes as an expert. The power plant and auxiliary services of a rice mill are described, as well as the buildings required. A chapter is devoted to the enemies of rice and methods of combating them, special attention being devoted to the rice weevil, which so frequently causes serious loss in stored rice. The composition and food value of rice receive brief consideration, and some useful hints are given on the proper method of cooking the grain. The book concludes with a short bibliography.

ZUCKERROHR. By H. C. Prinsen-Geerligs. Monographien zur Landwirtschaft warmer Länder, No. 26. Pp. 123, 7½ × 5. (Hamburg: Deutscher Auslandverlag Walter Bangert, 1925.) Price 5 Reich-Marks.

Within the small compass of this book is presented a concise account in German of the sugar-cane and its products. The subject is divided into five sections, the first of which deals with the botany of the cane, its habit, cane varieties, propagation and selection, and the chemical composition. The next two sections are concerned with the climatic conditions, soils and cultural methods of the various sugar-producing countries, and with the more important diseases and insect pests of the cane, suitable remedial measures for which are indicated. In the fourth section, the harvesting of the cane and the methods employed for the extraction of sugar are described, and a summary is given of the yields and cost of production in different countries. The fifth section briefly describes the different grades of sugar and syrup, their composition, and the purposes for which they are employed. Brief mention is made of some of the distillation products, and of bagasse and sugar-cane wax. The last section contains a short history of the sugar-cane, its geographical distribution, some statistics of world production, and a bibliography of the most important literature on cane sugar cultivation and manufacture. The work forms an excellent summary of the subject.

COMMERCIAL FEEDS. A Handbook for the Buyer and Seller. By W. H. Strowd, Ph.D. Pp. vii + 288, 7¾ × 5¼. (Madison, Wisconsin: The Strowd Company, 1925.) Price $3.00.

This book is designed to supply to farmers, stock owners and others interested in feeding-stuffs information regarding the origin, preparation and nutritive value of such materials. The author states that he has made a "frank and sincere effort to tell the truth about commercial feeds."

The subject is dealt with from the standpoint of American conditions, and the book appeals primarily to the "feed-man" in the United States. The book opens with a short description of the constituents of feeding-stuffs, their function and importance, and a chapter on balanced rations and feeding standards. Then follow chapters devoted to the most important materials and their products, such as wheat, rye, linseed, maize, oats, barley, rice, meat, fish, sugar-beet and cane, and dairy and miscellaneous products. The requirements of horses, cattle, pigs and poultry are outlined, and suitable rations prescribed, while the last six chapters of the book discuss the position and conditions of the feeding-stuff industry in the United States, the legal side of the subject, and the valuation of feeding materials.

ONZE KOLONIALE LANDBOUW: III. DE KINACULTUUR. Door Dr. A. Groothoff, oud Adjunct-Directeur der Gouvernements Kinaonderneming in Nederlandsch Oost-Indië, Derde druk. Pp. 122, 9 × 6¼. (Haarlem: H. D. Tjeenk Willink and Zoon, 1925.) Price Fl. 2.25, in paper covers; Fl. 3, bound.

This little volume, now in its third edition, is one of a series of twelve popular handbooks dealing with the agricultural industries of the Dutch East Indies prepared under the editorship of Dr. J. Dekker, formerly Director of the Commercial Museum of the Colonial Institute at Haarlem.

Modern handbooks dealing with the cultivation of cinchona and the manufacture of quinine from the bark are not numerous and an English translation of this excellent little book would be acceptable in this country. While claiming to be no more than a " popular " account of the subject, it is but just to mention that the book is an example of the best type of popular work, inasmuch as the author has succeeded in presenting to the lay reader an interesting account of his subject which is technically accurate and by no means without value to the more serious enquirer.

In the first two chapters there is an account of the history of quinine since its introduction from South America, and of the action which resulted in the establishment of plantations of the cinchona tree in Asia. The characters of the species cultivated are described in the chapter on the botany of cinchona, which also gives an account of the anatomy of the bark. The cultivation of the tree is dealt with at length from the preparation of the soil to the treatment of pests and diseases, and the methods of harvesting, drying and packing are also described. A chapter of several sections gives an account of the scientific and applied aspects of the chemistry of cinchona, including a useful summary of the more important facts regarding the influence of variable factors, such as the age of the tree, season, soil characters, manuring and shade, upon the proportion of alkaloid in the bark. In this section the author has drawn upon the information contained in a paper written by him in 1919, since the last edition of the book. There is a chapter dealing with the use of quinine as a drug in the treatment of malaria, and the volume concludes with an account of the trade in cinchona products and the present state of cinchona cultivation throughout the world.

The present edition records no important changes in the methods of the cinchona industry, but the book has been revised throughout, and certain chapters have been re-written. The illustrations are good and well chosen.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Revised by W. Harrison Martindale, Ph.D., Ph.Ch., F.C.S., and W. Wynn Westcott, M.B. Lond., D.P.H. Eighteenth Edition. Vol. II. Pp. xlii + 728, 6½ × 4. (London: H. K. Lewis & Co., Ltd., 1925.) Price 20*s*.

This work forms an addendum to the first volume of the eighteenth edition of the *Extra Pharmacopœia*, which was published last October (see this BULLETIN, 1924, **22**, 527). It deals chiefly with analytical, experimental and research work relating to drugs, covers an enormous range of subjects, and forms a record of scientific progress in such matters as the physiological standardisation of drugs, the recognition of organic chemicals, iontophoresis, radiology, the disintegration products of radium, uranium and thorium, the antiseptic powers of chemicals and disinfectants, the analysis of pathological material and of water, milk, etc. Bacteriological and clinical notes are also supplied with reference to special diseases, and particulars are given relating to proprietary medicines.

A full general index to the two volumes is provided which gives the dose of most of the drugs and preparations mentioned. The work is remarkable for the enormous amount of information which it contains and the concise form in which it is presented. It will, like the earlier editions, prove indispensable to the physician and pharmacist, and of great value to all who are in any way interested in the subject of materia medica.

PRINCIPLES AND PRACTICE OF INDUSTRIAL DISTILLATION. By E. Hausbrand. Translated from the Fourth, New and Enlarged, German Edition by E. Howard Tripp, Ph.D. (Marburg). Pp. xx + 300, 9 × 5¾. With 21 figures, 68 tables and 16 charts. (London: Chapman & Hall, Ltd., 1925.) Price 21*s*.

This is a translation of Hausbrand's *Die Wirkungsweise der Rektifizier- und Destillier-Apparate*, which is well known as an authoritative and standard work on the theory of distillation processes. The principles underlying the fractional distillation of liquid mixtures are carefully expounded without entering into details of the construction of the necessary plant. The changes which occur in the apparatus are first elucidated and afterwards a discussion is given of the masses and movements of vapours and liquids and the theoretical quantities of heat to be applied or recovered. The relevant mathematical expressions are then deduced and, finally, a demonstration is provided, with the aid of numerous practical examples, of the manner in which these expressions may be used to calculate the required dimensions of the fractionating columns to be employed in separating various liquid mixtures, viz. ethyl alcohol and water, methyl alcohol and water, acetone and water, acetone and methyl alcohol, acetone and ethyl alcohol, methyl alcohol and ethyl alcohol, acetic acid and water, formic acid and water, ammonia and water, nitrogen and oxygen, nitrogen and argon, and water and nitric acid.

The work has been translated with great skill, and the translator " holding that fidelity to form must be subservient to clearness of expression . . . has not hesitated to sacrifice the former when these two ideals come into conflict." The hope is expressed that the book will be found useful not only by the works chemist and the practical chemical engineer, but also by students and teachers in universities and technical colleges.

TIMBERS OF TROPICAL AMERICA. By Samuel J. Record, M.A., M.F., and Clayton D. Mell, B.A., M.F. Pp. xviii + 610, 10 × 6½. (New Haven : Yale University Press ; London : Humphrey Milford, Oxford University Press, 1924.) Price 45*s*.

For generations certain countries of tropical America and the West Indies have furnished the world with large quantities of some of the most valuable timbers entering commerce. As a result, extensive forests have been greatly depleted or even cut out altogether, and countries formerly supplying famous timbers no longer furnish appreciable quantities of the woods to the world's markets. Nevertheless, the exploitation of the forests of the tropical American region has been relatively localised, chiefly owing to difficulties of transport, and, as is well known, there are still vast areas of primeval forest whose resources are yet far from being completely known, either as regards extent or character. These regions comprise one of the few remaining areas of untouched forest, and it is probable that they are destined to play an important rôle as future sources of supply of commercial timbers (more especially hardwoods) to meet the growing scarcity resulting from the heavy cutting taking place in most forested countries.

The prospects of marketing selected timbers from these rich forests depends to a large degree upon the availability of reliable particulars regarding the characters of the woods and the extent of more or less accessible supplies. Such information is a powerful complement to the purely commercial operations needed in the marketing of " new " timbers, and much waste of money and disappointment would be avoided if the acquisition of reliable particulars of the woods were regarded as a necessary preliminary to commercial action. The fine book under notice has been designed to meet the needs of the case, so far as is possible, as regards the timbers of tropical America, and to serve as a basis for the further investigations required in dealing with so vast a field of enquiry. The foundations have been well laid and a superstructure of no mean proportions and of much scientific and practical value has been erected upon them.

There are two parts in the book. The first (*The*

Countries and their Forests), written by Mr. Mell, describes the forests of the countries concerned, which comprise the great chain of West India Islands, Mexico, British Honduras, Guatemala, Honduras, Salvador, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, the Guianas, Ecuador, Peru, Bolivia, Chile, Argentina, Paraguay, Uruguay and Brazil. The forests consist chiefly of hardwood (i.e., non-coniferous) species. There are valuable quantities of conifers in the Mexican highlands, in areas of Central America and to a much less extent in Santo Domingo, and there are considerable forests of Parana pine (*Araucaria brasiliana*, Lamb.) in southern Brazil ; but these coniferous areas are relatively small in extent and there is already an active trade in certain of the timbers. In character, the forests are (generally speaking) " mixed " forests, the number of associated species being usually large, though the dominant trees (usually those of most commercial value) are of comparatively few kinds in a given area. In many instances, however, there are nearly pure stands of commercial timber trees, as in the case of crabwood (*Carapa guianensis*, Aubl.) in Venezuela and the Guianas, mora (*Dimorphandra Mora*, B. and H.) and possum wood (*Hura crepitans*, L.) in Surinam, and white quebracho (*Aspidosperma Quebracho-blanco*, Schl.), in the Argentine ; while in other cases single species predominate over large areas.

The forests of tropical America, therefore, offer chiefly hardwoods. The author considers that Mexico, Central America, northern South America and the lower Amazon offer the best opportunities for timber exploitation in the early future. The northern countries of South America require even at present more timber than they can produce, and it seems likely that the exploitation of the timber resources of the upper Amazon will be for long deferred. The information afforded regarding the timber resources of the British countries is interesting and complete as regards main features. British Honduras and British Guiana are the most important countries concerned and reference is made to the difficulties in the way of extensive exploitation of the valuable forests of the latter country which, in spite of its timber wealth, imports large quantities of lumber and lumber manufactures from the United States. Of the West Indian Islands, apart from Trinidad, Dominica contains the most extensive and important tracts of virgin forest which so far have escaped exploitation as a result of inaccessibility.

The second part of the book (" The Trees and their Timbers "), which is mainly the work of Prof. Record, contains detailed description of the timbers. The system of classification is botanical, the woods being grouped according to the natural families of the trees yielding them, the families (75 in all) being arranged in botanical sequence according to the classification of Engler and Gilg (1912). This method, in conjunction with the copious index, is undoubtedly the most satisfactory way (even from the "practical" point of view) of dealing with a difficult problem. A short account of important characters of each family is followed by a description of the genera and species in such detail as their importance appears to warrant or available information allows. In practically all cases the description includes details of the structure of the timber, this information in most cases being obtained from the direct observation of specimens available in the School of Forestry at Yale University. The special value of these specimens lies in the fact that they are accompanied by named botanical material derived from the same trees, thus affording positive identification.

The field covered by the book is very great and, in view of the facts that the material and relative literature is often fragmentary or non-existent, "the work is necessarily of the nature of a general reconnaissance." The experience and reputation of each of the authors in his respective field of work, however, afford an assurance of the reliance which may be placed upon the information which is now made available both to the botanist and to the timber trade.

If suggestions may be made for minor improvements in a future edition, specific reference to the locally important government "Mora forest" of Trinidad might be included in the account of the forests of that colony; while, as regards British Guiana, the remark that "many of the timbers have long been known in the English markets" is perhaps a statement of what might have been the case under more favourable circumstances. In the reference to the genus Chlorophora, mention might be made of the West African species *Chlorophora excelsa*, Benth. and Hook., since this tree furnishes one of the most valuable timbers of tropical Africa ("African teak"), which differs in character from the allied "fustic" (*Chlorophora tinctoria*, Gaud.) of the tropical American region.

ENEMIES OF TIMBER: DRY ROT AND THE DEATH-WATCH BEETLE. By Ernest G. Blake, M.R.S.I. Pp. xvii + 206, 8½ × 5½. (London: Chapman & Hall, Ltd., 1925.) Price 12*s*. 6*d*.

Probably more structural timber is destroyed by the two enemies dealt with in this book than by any other cause, and the account given of their origin and life-history, the damage they cause, and methods for their extermination, forms a good introduction to the study of timber destruction generally. In addition to the main subjects of the book, there is a chapter on the nature of timber and its liability to decay, and another on the furniture beetle.

GOLD COAST PLANT DISEASES. By R. H. Bunting, F.L.S., and H. A. Dade, A.R.C.S. Pp. 124, 8¾ × 6. (London: The Crown Agents for the Colonies.) Price 6*s.*

The authors have performed a useful work in presenting this admittedly preliminary survey of the fungoid diseases affecting cultivated plants in the Gold Coast. There is still much to be learnt regarding the occurrence of the diseases in the Colony and one of the objects of issuing the present volume is to induce local observers to augment the existing knowledge. It is pointed out that the whole-hearted assistance of the farmers is necessary, if the efforts of the Governments to avert such calamity as has befallen other countries by the agency of plant diseases are to be successful. This is particularly true in the case of the Gold Coast, whose prosperity depends to such a great extent on a single crop, cocoa.

After an introductory chapter on the symptoms and causes of disease and methods of control, the principal diseases of the various crops are dealt with. Naturally, chief prominence is given to those of cocoa, but other permanent crops, such as coffee, kola, Para rubber, citrus and palms, are dealt with, as well as what the authors term annual plants. Under the last-named heading are included cotton, ground-nuts, maize, millets, rice and tobacco, and also cassava, sweet potato and yams. In all the most important diseases particulars are given regarding symptoms, the causative or associated fungus, predisposing conditions, dissemination of the disease and methods of control. In the case of black pod, mealy pod, pod rot and white root diseases of cocoa, the text is augmented by reproductions in colour of what appear to be small posters, showing the characteristic appearance of diseased parts, and containing a short description of the disease with methods of control. There are also 18 plates of reproductions from photographs, illustrating affected plants, mostly cocoa trees.

The Plants (Injurious Pests) Ordinance, 1923, and an Order by the Governor made under that Ordinance are reprinted in full. A list is given of all fungi collected in the Gold Coast Colony and its Dependencies which have so far been identified and there is a short glossary of technical terms.

THE VEGETATION OF BURMA FROM AN ECOLOGICAL STANDPOINT. By L. Dudley Stamp, B.A., D.Sc. (Lond.), A.K.C., F.G.S., I.E.S. Pp. vi + 58, 10 × 8. (Calcutta and London: Thacker, Spink & Co., 1925.) Price 11*s*. 6*d*.

This volume is No. 1 of a series of Research Monographs, issued on behalf of the University of Rangoon. It deals with the varied vegetation of the whole of Burma in a manner not previously attempted and forms an extension of a paper on the ecology of part of the dry belt of Burma by Prof. Stamp and Mr. Leslie Lord, published in the *Journal of Ecology* in 1923. The extraordinary variations of rainfall in Burma (from 20 to 200 inches within a few score miles) has produced most interesting changes in vegetation, whilst the varied geological formations and the consequently varied soils are also potent factors in the ecology of the country, sometimes accentuating, sometimes nullifying, the effects of climate. These factors and the effect of the different altitudes combine to make Burma a most interesting country from the point of view of plant formations and their distribution. The survey of these formations given by Professor Stamp is necessarily in some cases rather superficial, since there are large areas which it has been impossible to study hitherto. He has, however, performed a useful work in collecting together the scattered literature and adding his own invaluable contribution to the subject.

After a discussion of the factors governing the distribution of vegetation, such as elevation, climate, geology and soil, the author describes the main types of vegetation met with in Burma and their natural relationships. These main types he divides into thirty-five, six of which form the mountain vegetation (above 3,000 feet), twenty-five the lowland vegetation (below 3,000 feet), and the remaining four seral communities (natural or semi-natural vegetation which has not yet reached the normal climatic "climax" community of the locality in question, e.g. the vegetation of cultivated or lately-cultivated lands). In the last section of the book, on the relation between geology and ecology, the author emphasises the great importance of a study of the natural vegetation on agricultural and forestry problems and gives a series of maps showing the close relationship between the distribution of forest types and the underlying rocks.

The book is very well produced and is illustrated with 28 plates and 12 illustrations in the text. There is a good bibliography, a list of geological maps of Burma and full general and botanical indexes.

NATURE TEACHING. Based upon the General Principles of Agriculture for the Use of Schools. By Sir Francis Watts, K.C.M.G., D.Sc., F.I.C., F.C.S. Fifth edition. Pp. vii + 216, 7½ × 5. Published on behalf of the Imperial College of Tropical Agriculture. (London : The West India Committee, 1925.) Price 3*s*. 6*d*.

In the new edition of this well-known work, a note has been inserted on Mendelism and additions have been made concerning leaves and their functions, while the section on experimental work on the soil has been slightly extended. The chapters on insects and fungi have been re-written to bring the information into line with recent ideas and developments, and the classified list of plants arranged under habitats and the index of common names have been extended. The book is primarily intended for the guidance and information of the elementary and secondary school teacher in the West Indies, and should continue to prove a valuable guide for the preparation of lessons and practical work.

INTRODUCTION TO PLANT ANATOMY. By Arthur J. Eames and Laurence H. MacDaniels. Pp. 201, 9 × 6, Illustrated. (New York and London : McGraw-Hill Book Co., Inc., 1925.) Price 17*s*. 6*d*.

This book undoubtedly fills a gap in the list of botanical textbooks. So far as we are aware, there is no other work which so satisfactorily serves as an introduction to the anatomy of vascular plants. The book should be most useful to teachers organising courses of instruction in this subject, and to students and other workers who require to consult a reliable, well-arranged reference text on a subject which has a very scattered literature. The first four chapters deal with the general histology of the cell and tissue elements, and are followed by studies of the primary and secondary tissues of the vascular plant. The principal organs of the plant body are then described and there are special chapters on ecological histology and the history of the study of plant anatomy. The extent of the field covered has necessitated much summarisation, and in cases tested the work appears to have been skilfully done. Each chapter concludes with a short, well-selected bibliography, which should be helpful to advanced students and others. The book is well illustrated and excellently produced.

PRINCIPLES OF GENETICS : AN ELEMENTARY TEXT WITH PROBLEMS. By Edmund W. Sinnott and L. C. Dunn. Pp. xvii + 385, 9 × 6. (New York and London : McGraw-Hill Book Co., Inc., 1925.). Price 17*s*. 6*d*.

This book, written jointly by a botanist and a zoologist, is intended to afford a concise account of the general principles of genetics as understood at the present day, without laying undue stress on any special phase of the subject. The work is not intended as a guide to the practical aspects of the science, and emphasis has been laid on principles rather than on their industrial application. The first ten chapters, therefore, are concerned with such subjects as heredity and variation, Mendel's laws, and the chromosome theory of inheritance. A further chapter suggests various ways in which these principles of genetics may be of value to the practical breeder, and concluding sections deal with inheritance in man, and certain aspects of eugenics. The authors place much faith in the educational value of the solution of "problems" by students, and a feature of the book is a series of "questions for thought, discussion, problems and reference assignments" which accompany individual chapters. The volume contains a large number of useful illustrations.

BACTERIOLOGY: A TEXTBOOK ON FUNDAMENTALS. By Stanley Thomas, M.S., M.A. Pp. xiii + 201, 9¼ × 6¼. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 12*s*. 6*d*.

This volume is written to meet the need for a textbook treating of the fundamentals of bacteriology and suitable for use in teaching elementary bacteriology to mixed classes of engineering, chemical and medical students. An introductory chapter is devoted to a consideration of the general conception of life and life's processes. Chapters follow on the history, classification, morphology and physiology of bacteria. The classification employed is that recently adopted by the Society of American Bacteriologists. The bacteria occurring in water are considered and a rough outline is given of the various methods employed on a large scale for the purification of water for town supply purposes. The bacteriology of sewage and the elimination of bacteria in connection with sewage disposal are dealt with, and a description is given of the bacteria in the soil and the bacterial processes occurring there. A section on bacteria in foods includes studies of organisms which are used in their preparation; on those which cause spoilage of food products, and on pathogenic organisms which are transmissible through food. Other sections are concerned with pathogenic bacteria, immunity, hygiene and sanitation. The last chapter, entitled "Bacteria in Industry," gives a very short account of those industries in which bacteria play a part, such as the production of alcohol, acetic acid, lactic acid, butyl alcohol and acetone; leather manufacture; the retting of fibres ; and the tea and tobacco industries.

The work is well written and should fulfil the purpose for which it was intended. The subject matter covers a large field and is, therefore, rather condensed. Those requiring more exhaustive information will, as the author states, have to seek it elsewhere, and references are therefore given to articles on special subjects.

General Zoölogy. By H. L. Wieman, Professor of Zoology, University of Cincinnati. Pp. ix + 312, 9¼ × 6¼. (London: McGraw-Hill Publishing Co., Ltd., 1925.) Price 15*s*.

This work was written as a textbook for students of Zoölogy in general and for medical students in particular. It is designed to supplement the practical study of animal forms by giving an account of the outstanding facts and principles of the subject which are not adequately dealt with in the laboratory. Thus the book first considers such general topics as morphology and physiology, the protoplasmic doctrine, the cell doctrine, taxonomy and adaptation, and then proceeds to treat of organology by reference to common laboratory types. This is followed by a section dealing with the functional side of the animal organism, including chapters on metabolism and endocrine secretions. The subjects of cell-division, gametogenesis and ontogenesis are next discussed, and then ensue chapters on evolution and heredity. The final chapter gives a brief systematic review of the animal phyla and should enable the student to gain a clearer appreciation of the general biological principles dealt with in the previous sections and to obtain a firm knowledge of the terminology of classification. At the end of each chapter a list is given of suitable works for collateral reading.

The book is written in a very interesting and illuminating manner and is profusely illustrated, most of the drawings being based on the author's own material.

Manganese Ore with Special Reference to Georgian Ore. By Datico Zereteli. Pp. vi + 136, 10 × 7. (London: Dryden Press, 1925.) Price 8s. 6*d*.

The first chapter of this book contains preliminary notes on manganese, its ores, uses, market and statistics. The next three chapters deal with sources of manganese ore. There are several rather glaring mistakes in the spelling of names of places. There are some erroneous statements as well, thus: the Gaisinsk district, near the

Black Sea, is stated to be 20 miles from Odessa; the distance is 220 miles. The Greek production of manganese ore in 1902 is given as 1,500 tons: this should be 15,000 tons; the Japanese manganese ores are said to average 82 per cent. of manganese—this should be 52 per cent.

The description of the Georgian manganese industry comprises 40 pages. Although vertical sections of the Zeda-Rgani, Darkveti and Itkhvici deposits, after Bogdanoff, are shown in the text, the description of the manganiferous beds from a geological point of view is very meagre, and the age (Lower Eocene) of the deposits is not even mentioned. On the other hand, there is a good deal of information about the quantity and quality of the ore available, including various estimates. One by H. Dekanosichvile, drawn up in 1924, puts the total quantity at about 219 million tons, of which 73 million tons have already been quarried, leaving 146 million tons as the present reserves. Output figures are given from 1913 to 1923 inclusive. The output was highest in 1913 with 59,188,000 poods (951,235 long tons), and lowest in 1918, with 1,583,300 poods. In 1922 and 1923, the production amounted to 3,245,100 and 11,846,000 poods respectively, the last being the highest figure since 1917, with 12,488,000 poods. In 1923, 18 washing plants were in operation, producing 10,997,500 poods. The transport of the ore to railway termini and seaports is fully described, as well as the present organisation of the Georgian industry, including the "temo" or society of manganese ore exporters. Three chapters are devoted to the chief consumers of manganese ore, the cost of manganese ore in different countries and the organisation of the manganese market, respectively. The work concludes with forms of Georgian and Indian contracts, a list of books consulted and a map of Georgia.

Although the book is in some respects disappointing, it supplements and brings up-to-date the works of Ghambashidze and others on the Georgian manganese deposits, and is on that account a useful addition to the available literature on this subject.

MOLYBDENUM, CERIUM AND RELATED ALLOY STEELS. By H. W. Gillett (formerly Chief Alloy Chemist, U.S. Bureau of Mines), and E. L. Mack (formerly Assistant Alloy Chemist, U.S. Bureau of Mines). Pp. 299, 9 × 6. (New York: The Chemical Catalog Co. Inc., 1925.) Price $4.

This book is one of the excellent monograph series issued by the American Chemical Society.

After a brief discussion on the effect of various alloying elements in steel, the authors proceed to deal in detail with the properties and testing of alloy steels, with particular reference to those of molybdenum. Many useful tables, curves and diagrams are included, and the composition, heat treatment and methods of testing of the experimental steels used are given in appendixes.

Many references to modern literature are given, and are collected in an appendix of 323 items.

The book should be of great service to those desirous of keeping in touch with recent research work on alloy steels.

COPPER: A Survey of the Sources from whence the Metal is obtained, the Methods of its Manufacture, the Nature of its Uses and the Conditions of the Trade. By N. E. Crump. Pp. vii + 246, 8¾ × 5½. (London: William Rider & Son, Ltd., 1925.) Price 10*s.* 6*d.*

The object of this book, as the title implies, is to give a general account of the copper industry. In view of the magnitude of the subject, the reader will be prepared for brevity of treatment, but the introduction, dealing with the mineralogy and geology of copper deposits, is too brief to be of much use. Moreover, though brief, it abounds in misprints and inaccuracies.

The chapters dealing respectively with smelting, refining and uses of copper are more accurate. It is to these chapters that the work chiefly owes any value it may possess.

The last part, which deals with the sources of supply, lacks balance. For instance, two pages are devoted to Great Britain, producing about 100 tons per annum, while only one page is given to Chile where over 180,000 tons were produced in 1924. Attention is drawn to the production that may be expected from Northern Rhodesia, but, unfortunately, it is included under the heading "Katanga, Belgian Congo."

The book is written in an interesting way. It is well printed, and is provided with a good index. If a second edition is called for, however, the need for careful correction and revision manifested by the first edition should receive the author's attention.

MÉTALLURGIE DU CUIVRE ET ALLIAGES DE CUIVRE. By M. Altmayer et Léon Guillet. Pp. 714, 9¼ × 6¼. (Paris: J. B. Baillière et Fils, 1925.) Price 65 frs., in paper covers.

The first part of this book, written by M. Altmayer, deals with the metallurgy, and the second part, by M.

Léon Guillet, with alloys of copper. The volume is one of a series on mining and metallurgy, issued by the same publishers under the general direction of the second author mentioned.

Under metallurgy is given a general review of the copper industry, together with a discussion of the physical and chemical properties of the metal, the ore-minerals of copper and the principal compounds from the smelter's point of view, methods of assay and analysis, and sale-contracts for copper ores. Following this, there are nine chapters that deal with various means of extracting copper from its ores and with refining methods. Although the book was published in 1925, the latest statistics given appear to be for the year 1920. The chapter dealing with wet methods of extracting copper from its ores is much too short, considering the growing importance of these methods.

The second part, dealing with alloys, gives a good account of the constitution and characteristics of the more important copper alloys.

The "table alphabétique" given at the end of the book is merely an alphabetical arrangement of sectional headings, and is a poor substitute for an index.

The book is well printed and fully illustrated, the plates of photomicrographs of alloys being particularly good.

A COURSE OF METALLURGY FOR ENGINEERS. By F. C. Thompson. Pp. 240, 8½ × 5½. (London: H. F. & G. Witherby, 1925.) Price 25*s*.

As suggested in the title, this book gives such information as is required by the mechanical engineer on the various metals and alloys used by him, but it is also a useful introductory textbook to the student of general metallurgy.

An opening chapter gives, in a space of 21 pages, an account without details of the iron ores and their smelting properties, the varieties of cast iron and steel and the methods of their production. The greater part of the rest of the book is devoted to the compositions, microscopic structure, heat treatment and mechanical and other properties of all classes of steel, cast iron, brass, bronze, aluminium alloys and bearing metals. Steel is treated at some length, the other metals, especially cast iron, being dealt with more briefly. A large number of excellent photomicrographs show the effects of varying the compositions of metals and of different heat and mechanical treatment.

The book concludes with tables of analysis of typical wrought irons and steels and mechanical tests, and also a bibliography intended for those wishing to follow up the study of any branches of the subject,

The book is well printed and illustrated, and can be recommended as containing a large amount of recent metallurgical information in a well-written and compact form.

SHALE OIL. By Ralph H. McKee, and others. American Chemical Society Monograph Series. Pp. 326, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1925.) Price $4.50.

An introductory chapter on shale oil, by Dr. McKee, is followed by chapters on the origin, geology and distribution of oil shales, by Professor R. D. George. With regard to the Norfolk shales, the oil yield is said to range from 40 to 90 or more U.S. gallons per ton, and it is further stated that " drill prospecting has proved the existence of billions of tons of shale of workable thickness and relatively high oil yield, although the quality of the oil is low, because of its high sulphur content." The above data appear to have been based on information published in 1916. It will be generally conceded that later explorations have proved that the Norfolk oil shales are disappointing, both as regards quantity and quality.

The oil shales of Canada are described by S. C. Ells, who is personally familiar with those of Nova Scotia, New Brunswick, Gaspé Peninsula (Quebec), Northern Ontario, Manitoba and Saskatchewan. According to a table on page 49, the Albert Series, containing oil shales, of New Brunswick, is of pre-Cambrian age, but Canadian geologists usually regard it as belonging to the Carboniferous system.

There are interesting chapters on kerogen, the oil-yielding material of oil shales, by Drs. McKee and R. T. Goodwin, and the refining of shale oil by Dr. E. E. Lyder. W. A. Hamor deals with the economics of the shale industry, and predicts that it will ultimately assume commercial importance in other places than Scotland, " but many years and the services of the highest type of business, executive and technical ability, backed by large capital, will be required before it reaches this status."

Basic factors of the shale oil industry are ably dealt with by Martin S. Gavin, Oil Shale Technologist of the U.S. Bureau of Mines.

No less than 26 American experimental oil shale distillation plants are described in the text by Hamor, with illustrations. The Catlin retort of the Catlin Shale Products Co., Elwo, Nevada, appears to be one of the best, from a technical point of view. This company is reported to have constructed a still more satisfactory retort, capable of the daily treatment of 100 tons of shale—a detailed description of which is not available.

More than one-third of the book is devoted to abstracts of shale oil articles and a list of patents. This portion will be found very useful for reference purposes.

This monograph, which is a valuable and up-to-date account of the subject dealt with, should be in the hands of all interested in the production of shale oil.

THE CONVERSION OF COAL INTO OILS. By Dr. Franz Fucher, translated by R. Lessing, Ph.D., F.C.S., M.I.Chem. E., M.Inst. P.T. Pp. 284, 9¾ × 7½. (London: Ernest Benn, Ltd., 1925.) Price 36*s*.

This book gives a critical review of the problem of the conversion of coal into liquid compounds. Much of the work described has been carried out under the direction of the author at the Kaiser-Wilhelm-Institut für Kohlenforschung, at Mühlheim-Ruhr, but at the same time the work of other investigators has not been neglected. The English edition closely follows the German text, but a few notes on the later developments of low-temperature carbonisation, the Lessing process of separation of oils and pitch from tar, and the hydrogenation of coal have been added.

The question is considered under the headings of production of primary tar, hydrogenation of coal, and synthetic conversion preceded by gasification as in the synthol process mentioned below. There are also short chapters on the extraction of coal by solvents and on the production of hydrocarbons from carbides.

The author considers that synthetic processes based on the gasification of semi-coke after a preliminary recovery of primary tar offer the most promising means of converting coal into oils. He gives the results of much work on the production of an oily product, "synthol," from water gas enriched with additional hydrogen by passing the mixture over a suitable catalyst at high pressures. The oil formed was a complex mixture, consisting largely of higher aldehydes, ketones and alcohols, and was found to be a satisfactory motor fuel.

The experimental work is described in great detail, a full bibliography is appended, and the book should be of much value to those interested in this important problem.

Low Temperature Distillation. By S. H. North and J. B. Garbe. Pp. viii + 216, 8¾ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1925.) Price 15*s*.

Much has been published recently on this subject, and in the present volume the authors have considered the question mainly from the point of view of home oil supply from small and cannel coal, shale, lignite, and peat. After a brief historical survey, a concise account is given of a number of the processes which have been tried on a fair scale; the descriptions being augmented by well-reproduced diagrams of the plant. Other subjects dealt with include the raw materials available for treatment in Great Britain, the nature of the oils obtainable, and the briquetting of the carbonaceous residue resulting from the treatment. The concluding chapters deal very briefly with the distribution of oil shale, lignite and peat deposits, and the possibility of utilising these as sources of fuel oil.

The work is very readable, and should be of service to those requiring a concise and not too technical survey of the subject.

Bituminous Substances: Scientific Progress of Practical Importance during the last 15 years. By P. E. Spielmann, Ph.D., B.Sc., F.I.C. Pp. xv + 206, 8½ × 5½. (London: Ernest Benn, Ltd., 1925.) Price 15*s*.

After a brief historical introduction, the author divides his subject into four sections: (1) composition and origin; (2) physical and chemical properties; (3) effect of heat, ageing and solvents, and (4) physical and chemical tests.

The chapter on physical and chemical properties contains much interesting data concerning the light sensitiveness and colloidal character of bitumen, and in the succeeding chapter the relation between temperature and other physical constants is shown by means of numerous graphs.

The chapter dealing with physical and chemical tests contains much useful matter which bears evidence of the author's association with the asphalt industry.

The nomenclature of bituminous substances is discussed in appendix A, whilst in appendix B are described the standard methods for testing asphalts as prescribed by the Institute of Petroleum Technologists.

Dr. Spielmann has produced an interesting résumé of the scientific work which has been carried out recently on bituminous substances, but after reading the work one has to conclude that although much has been done in regard to the technical testing, little has been achieved in the direction of elucidating the constitution of these complex bodies.

THE CHEMICAL COLORING OF METALS AND ALLIED PROCESSES. By Samuel Field, A.R.C.Sc. Lond., F.C.S., and Samuel Robert Bonney. Pp. xix + 264, 8½ × 5½. (London : Chapman & Hall, Ltd., 1925.) Price 10*s.* 6*d.*

The authors of this book, who are members of the staff of the Northampton Polytechnic Institute, London, are to be congratulated on a very useful piece of work. The first two chapters are devoted to a simple explanation of the chemistry involved in the colouring art ; Chapter III deals with corrosion of metals in air ; Chapter IV describes the general methods of colouring, while the next two chapters deal with the all-important subject of chemical and mechanical cleaning preparatory to the actual colouring. Chapter VII contains a short description of lacquering, after which follow two chapters on electro-deposition, two each on colouring copper and brass, one each on silver, gold, zinc and nickel, iron and tin, and aluminium. The last two chapters deal with various processes of colouring and decoration, and with general repairs. Appendixes include a glossary and a number of useful tables. A good index completes the book, which is concisely written, well printed and free from misprints.

While the work will be of considerable practical value to all those interested in this very fascinating subject, too much condensation appears to have been attempted in places. The statement on page 9 that " silver equals or excels copper in electrical conducting power," would appear to need some explanation, while the description of electro-deposition of brass, on page 105, is none too clear. In view of this condensation, the absence of a bibliography or of any references in the text is to be regretted.

The chapter on the colouring of aluminium is particularly interesting in view of the difficulties encountered in dealing with this metal, and the need for further research in this direction is evident. Incidentally, it may be mentioned that while the authors adopt the spelling " color," fortunately they have not adopted " aluminum."

BLACKS AND PITCHES. By H. M. Langton, M.A., B.Sc., A.I.C. Pp. xi + 179, 9¾ × 6¼. (London : Ernest Benn, Ltd., 1925.) Price 15*s.*

This work is one of a series of monographs on oil and colour chemistry issued under the general editorship of Dr. R. S. Morrell. The present volume aims at giving a concise account of the occurrence, preparation, properties and uses of the various black pigments employed in the colour and other industries.

About one-third of the book is devoted to the consideration of graphite and the several carbon blacks. The other products dealt with include natural bitumens and the pitches obtainable from coal-tar, wood-tar and fatty acids. The book has been written largely from the practical standpoint and includes much useful information on the trade standards adopted for the various products.

The author has produced a very useful and readable work and has increased its usefulness by including a number of good illustrations and appending a useful bibliography to each chapter.

East Kent Regional Planning Scheme Preliminary Survey, prepared for the Joint Town Planning Committee of Local Authorities by Patrick Abercrombie, in collaboration with John Archibald. Pp. xxi + 113, 12½ × 10. (Liverpool: University Press; London: Hodder & Stoughton, Ltd., 1925.) Price 10*s.*

The area covered by this preliminary survey comprises the East Kent Coalfield and surrounding districts. The real problem of the Regional Plan for East Kent consists in combining a policy of development with a policy of the preservation of the existing civilisation. Fortunately the colliery development is chiefly placed in the little inhabited Eastry, Bridge and Dover rural areas, where it can be disposed skilfully so as not to destroy any actual village. In the introduction it is pointed out that Kent could supply four times the present amount of power used in London and have enough for local industries as well.

The first part of the survey is divided into ten sections, dealing with: natural features—rainfall, natural topography, surface and underground geology, economic geology and surface values; agriculture and vegetation; archæological; administrative; population, health and housing; industrial survey—coal, ironstone and other economic minerals; communications—roads and railways; open spaces and natural reservations; Canterbury, Sandwich and the old villages; seaside resorts.

In the important industrial survey section, a useful plate shows the economic coalfield as well as the probable extent of the iron ore deposits. According to a list which is given, no less than 28 borings out of 39 have revealed workable coal, but up to the present no satisfactory correlation of the different coal seams has been made. The most productive of workable seams would appear to be the higher part of the Transitional and the lowest of the Middle Measures of the Carboniferous.

The Kent coals compare favourably with the famous

Welsh smokeless steam coal used for Admiralty purposes. The Ripple seam consists of 10 feet of remarkable good smokeless navigation steam coal, and contains 84·26 per cent. of fixed carbon—the calorific value being 8,355 calories. At the other extreme is the Rockefeller seam, half the thickness, and containing only 52·66 per cent. of fixed carbon. It is an exceptionally valuable coal for gas manufacturing purposes. Between these two extremes of carbon contents, 73 other seams have been analysed, providing coal for navigation, steam, house, general heating and gas and cooking purposes.

It is pointed out that the area between Bere boring and Deal will some day be exploited. Though deep, the coal seams are rich. Of seams 2 feet thick and upwards, there are 62 feet of coal at Oxney; 54 feet at Maydensole, and 46 feet at Ripple (including the 10-foot seam already mentioned).

Ironstone was found when enlarging the Dover borehole for coal. It is seen in the upper part of the Corallian Series of the Oolites, 656 feet from surface, and in the more northern part of the ore-field it occurs at a lower horizon in the Oxford Clay. At Farthingloe, a bed of ore 14 feet thick has been proved at a depth of 791 feet. It is estimated that there must be at least 100 million tons of ore, averaging 30 per cent. of metal, in these deposits.

The second part of the work is devoted to the future, and comprises twelve sections on: zoning outlines; ports; population; residential growth; communications —roads and railways; open spaces; considerations in coal working—subsidence, smoke and electric running and coal tips; water supply and drainage; electric power; small holdings and allotments; social and educational considerations; and methods of realisation. There is an appendix giving the inter-urban tonnage on the roads, which is graphically represented by a plate.

The work contains a large map in four sections, and 32 plates, and, although only a preliminary survey, it is a comprehensive one, and of great value for the future development of East Kent, not merely with regard to the coalfield, but also as to further town-planning, roads, railways, etc. It is well written, admirably printed, and excellently illustrated.

A CATALOGUE OF BRITISH SCIENTIFIC AND TECHNICAL BOOKS. Covering every Branch of Science and Technology carefully Classified and Indexed. New Edition. Entirely Revised and Enlarged. Pp. xxii + 489, 8½ × 5½. (London: British Science Guild, 1925). Price 12*s.* 6*d.*

The first edition of this useful Catalogue was issued in

1921. The new edition not only contains works published in the four years that have elapsed, but the opportunity has been taken to extend its scope in several directions. Official publications of scientific and technical value, published by H.M. Stationery Office, are now included and some of the sections, such as those of biology, metallurgy, science in general and textiles, have been greatly extended. The present edition comprises 9,515 titles, against 6,566 in the original edition. With few exceptions, only books in the lists of publishers at the end of December 1924 are included. The bibliographic particulars for each volume, viz. name of author or editor, title, size, number of pages, date of last edition, name of publisher and price, have been checked by the publishers themselves. Obviously, great care has been exercised in compiling the catalogue, but one or two slight errors have been overlooked. For example, the 1924 issue of *The Timbers of Commerce and Their Identification*, by H. Stone (p. 263), is not a 4th edition but a 4th impression of a book published in 1904, while the price of *Alien Flora of Britain*, by S. T. Dunn (p. 381), is 5*s.* not 2*s.* 6*d.* It may be suggested that in the next edition of this Catalogue the original date of publication be given in cases where a book is merely reprinted or reissued. To give 1924 as the date of books published originally in 1893 and 1905 is, to say the least, misleading.

NACHSCHLAGEBUCH DER NACHSCHLAGEWERKE FÜR DIE WIRTSCHAFTSPRAXIS. Nebst Anlagen: I. Verzeichnis wichtiger Wirtschaftszeitschriften aller Länder. II. Denkschrift: Das Hamburgische Welt-Wirtschafts-Archiv. Pp. xii + 98; iv + 54; 41. Herausgegeben im Auftrage des Hamburgischen Welt-Wirtschafts-Archiv von Dr. Paul Heile. (Hamburg: Verlag Wirtschaftsdienst, G.m.b.H., 1925.) Price 5 R.Mks.

This volume is an elaborately classified directory of works of reference concerned with economics, notably in relation to natural resources and raw materials. According to the author, it is essentially a statement of the publications systematically collected by the Hamburgische Welt-Wirtschafts-Archiv which, as explained in the special memoir which forms the second appendix to the volume, is the outcome of the Zentralstelle of the Hamburgische Kolonialinstitut founded in 1908. Originally concerned primarily with colonial questions as affecting the German overseas possessions, the organised collection of economic information relating to all the leading countries of the world soon became necessary, and the present directory is the outcome of the work commenced by the Zentralstelle and now carried on by the Welt-Wirtschafts-Archiv.

The main sections of the directory are concerned with general matters of international interest, geography, commercial raw materials, trade and other directories, telegraphic codes, dictionaries and newspapers. The classification of the books under their headings makes reference a rapid and easy task, but the number of works recorded is relatively not large and certain lists appear to be of a somewhat miscellaneous, if useful, character. The first appendix, comprising a list of selected commercial, trade and similar publications of the leading countries of the world, is a useful compilation which illustrates the wide resources of the Welt-Wirtschal

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BOOKS RECEIVED

PERFUMES, COSMETICS AND SOAPS, WITH ESPECIAL REFERENCE TO SYNTHETICS. By William A. Poucher, Ph.C. Volume I. Being a Dictionary of Raw Materials. Second Edition. Pp. ix + 304, 8¾ × 5¾. (London : Chapman & Hall, Ltd., 1925.) Price 16*s.*

RUBBER AND ENGINEERING. Being a Short Account of the Preparation and Properties of Rubber with Particular Reference to its Uses in the Engineering Industry. By H. P. Stevens, M.A., Ph.D., F.I.C., and B. D. Porritt, M.Sc., F.I.C., F.R.S.E. Pp. 32, 8½×5½. (Free on application to The Rubber Growers' Association, 2, 3, & 4, Idol Lane, Eastcheap, London, E.C.3).

THE USEFUL TREES OF NORTHERN NIGERIA. By H. V. Lely. Pp. xii + 128 + 120 full-page illustrations, 10½ × 8½. (London : The Crown Agents for the Colonies, 1925.) Price 10*s.*

MANUAL OF FORESTRY FOR THE NORTHEASTERN UNITED STATES. Being Volume I of *Forestry in New England*, revised. By Ralph Chipman Hawley, M.F., and Austin Foster Hawes, M.F. Pp. xii + 281, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1925.) Price 17*s.* 6*d.*

GARDENING IN THE TROPICS, ESPECIALLY WRITTEN FOR SCHOOL GARDENS IN TRINIDAD AND TOBAGO. By R. O. Williams. Pp. 64, 9½ × 6. (Trinidad : The Government Printer, 1924.) Price 2*s.*

AN INTRODUCTION TO HISTORIC GEOLOGY, WITH SPECIAL REFERENCE TO NORTH AMERICA. By William J. Miller. Pp. xvi + 399, 8¾ × 6. (London : Chapman & Hall, Ltd., 1925.) Price 13*s.* 6*d.*

VOL. XXIII, 1925

INDEX

Botanical names and titles of books are printed in italics and authors' names in capitals

PAGE
ABERCROMBIE, P., and ARCHIBALD, J., *East Kent Regional Scheme Preliminary Survey* .. 549
Acacia Lebbek bark, tanning properties .. 159, 162, 167
Agricultural Co-operation in the British Empire .. 267
Agriculture in the Netherland East Indies .. 51
Albizzia Lebbek bark, tanning properties .. 158, 161, 166
Alcohol from the nipa palm in North Borneo .. 50, 175
ALI, A. YUSUF, *The Making of India* .. 522
Alstonia congensis wood for paper-making .. 367
ALTMAYER, M., and GUILLET, L., *Métallurgie du Cuivre et Alliages de Cuivre* .. 543
Aluminium and Aluminium Alloys, The Metallurgy of .. 413
Aluminium sulphate, occurrence in Alberta .. 485
Anatomy and Physiology of the Honey-bee .. 411
ANDERSON, R. J., *The Metallurgy of Aluminium and Aluminium Alloys* .. 413
Anisophyllea laurina (monkey apple) timber from Sierra Leone, description, mechanical and working tests .. 8
Antimony Ores, Imperial Institute Monographs .. 47
Antimony, Organic Derivatives of .. 410
Arachis africana .. 305
,, *asiatica* .. 305
,, *hypogæa* (*see* Ground-nut)
ARCHIBALD, J. (*see* ABERCROMBIE, P.)
Argentina, petroleum in .. 98
Arsenic ore deposits of Australia .. 368
Asbestos, chrysotile, in New Zealand .. 80
,, deposits of Cyprus .. 485
Atlas, The Oxford Economic .. 266
Attalea speciosa (babassu) nuts, industry of South America .. 357
Australia, cement-making materials of New South Wales .. 487
,, , chromium ore deposits of New South Wales .. 488
,, , coal deposits of .. 125, 490
,, , cobalt ore deposits of Queensland .. 491

PAGE

Australia, copper-nickel ore deposits of Tasmania 499
„ , copper ore deposits 372
„ , cotton grading in Queensland 214
„ , cotton-growing in Queensland 363
„ , cotton-growing in Victoria 81
„ , dugong oil from 429
„ , enlargement of beet sugar factory at Maffra, Victoria 60
„ , gold deposits of 232, 376
„ , ground-nut industry of 68, 321
„ , iron ore deposits of 237
„ , monazite deposits of Tasmania 238
„ , oil shale deposits of 97, 500
„ , ratooning of cotton in Queensland 74
„ , silver ore deposits of 244
„ , South, arsenic ore deposits 268
„ , „ radio-active ore deposits of 503
Avodiré wood for paper-making 482

Babassu nuts, industry of South America 357
Bacteriology : A Textbook on Fundamentals 540
Bahamas, cement-making materials 41
Balsa wood from British Honduras, characters and working properties 4
„ „ „ „ „ , paper-making trials .. 14
Banana cultivation in the Canary Islands 168
„ , grading, packing and handling 353
Barbados, cement-making materials 41
BARTHOLOMEW, J. G., *The Oxford Economic Atlas* 266
Bauxite and Aluminium, Imperial Institute Monograph .. 196
Bauxite deposits of Ireland 486
„ „ „ Nyasaland 486
BEAR, F. E., *Soil Management* 129
Beet sugar (*see* Sugar, beet)
Belgian Congo, copper ore deposits of 229
Bentonite, distribution, characteristics and uses 86
Bermuda, cement-making materials 44
Bibliography of Sierra Leone, A 525
Bibliography relating to Colonial development and resources 103, 246, 384, 503
Bismuth Ores, Imperial Institute Monograph 47
Bituminous Substances 547
Blacks and Pitches 548
BLAKE, E. G., *Enemies of Timber* 536
„ „ *The Seasoning and Preservation of Timber* .. 269
BONNEY, S. R. (*see* FIELD, S.)
Books received for notice 133, 274, 419, 552
BOYSON, V. F., *The Falkland Islands* 120
Brazil, coffee pest, *Stephanoderes coffeæ*, in 61, 354
British Commonwealth and its Unsolved Problems, The 404

PAGE
British Empire Exhibition, Imperial Institute exhibits .. 196
„ Guiana, cement-making materials .. 42
„ „ , coconut industry .. 358
„ „ , palladium-mercury occurrence in .. 239
British Honduras, balsa or polak wood from, characters and working properties 4
„ „ , „ „ „ „ „ paper-making trials 14
„ „ , cement-making materials .. 42
British Honduras, Handbook of .. 525
British Honduras woods as paper-making materials .. 12
Brown, N. C. (*see* Moon, F.)
Buchanania latifolia bark, tanning properties .. 158, 161
Bunting, R. H., *Gold Coast Plant Diseases* .. 537
Burma, Vegetation of, from an Ecological Standpoint .. 538

Cadmium alloys .. 186
„ „ distribution .. 190
„ , metallurgy .. 183
„ ores .. 182
„ , production and prices .. 194
„ , properties .. 182
„ , uses .. 186
„ yellow .. 189
Caicos Islands, sisal hemp industry .. 84
Camphor from Dominica .. 275
„ leaves and twigs from Uganda .. 421
Canada, aluminium sulphate occurrence in Alberta .. 485
„ , beet sugar industry in Western .. 60
„ , coal deposits .. 368
„ , copper ore deposits .. 90, 228, 372, 491
„ , flax experiments in .. 219
„ , forest conservation .. 460
„ , gold deposits .. 91, 230, 373, 493
„ , hemp industry of .. 222
„ , lithium ore deposit in Manitoba .. 498
„ , maple sugar industry of .. 61
„ , oil shale deposits .. 378
„ , paper production .. 458
„ , petroleum in .. 379
„ , pulp-wood resources .. 456
„ , „ situation in .. 455
„ , silver ore deposits of .. 100
„ , wheat experiments .. 206
Canary Islands, banana cultivation in .. 168
Cane Sugar and its Manufacture .. 126
Careya arborea bark, tanning properties .. 158, 160, 165
Castor seed, cultivation in Morocco as a sand-binder .. 63
Catalogue of British Scientific and Technical Books .. 550
Cement-making materials of Bahamas .. 41

PAGE
Cement-making materials of Barbados 41
„ „ „ „ Bermuda 44
„ „ „ „ British Guiana 42
„ „ „ „ „ Honduras 42
„ „ „ „ „ Malaya 431
„ „ „ „ Ceylon 440
„ „ „ „ Cyprus 449
„ „ „ „ Fiji Islands 45
„ „ „ „ Hong Kong 447
„ „ „ „ Jamaica 33
„ „ „ „ Leeward Islands 10
„ „ „ „ Malta 451
„ „ „ „ New South Wales 487
„ „ „ „ North Borneo 434
„ „ „ „ Palestine 448
„ „ „ „ Sarawak 439
„ „ „ „ Trinidad 38
Cement manufacture and its possibilities in the Crown Colonies and Protectorates 32, 431
„ , Portland, revised British Standard Specification .. 472
„ testing, new machine for compacting cement-sand briquettes 50
Cereal Chemistry, Modern 126
Ceylon, cement-making materials 440
„ , ground-nut cultivation 312
Ceylon, its History, People, Commerce, Industries and Resources .. 121
Ceylon rubber research scheme, investigations conducted at Imperial Institute .. 135
„ „ „ „ , report on work 197
„ , sisal hemp experiments in 483
„ , suggested coconut research scheme in 64
Chemical Colouring of Metals and Allied Processes 548
CHENEY, R. H., *Coffee* 529
Chia seed (*Salvia hispanica*) cultivation in United States .. 478
CHRISTIANSEN, W. G., *Organic Derivatives of Antimony* .. 410
Chromium ore deposits of Albania and Macedonia 350
„ „ „ „ New South Wales 488
„ „ „ „ Transvaal 487
Cinnamomum Massoia bark from Papua 423
Cinnamomum parthenoxylon oil from Federated Malay States .. 428
Citrullus vulgaris seeds as a source of oil 149
Citrus oils 212
CLARKE, G. R., *Soil Acidity and its Relation to the Production of Nitrate and Ammonia in Woodland Soils* 129
Clay, Nyasaland, for manufacture of bricks, tiles, drain-pipes and pottery 281
Coal and Civilisation 415
Coal deposits of Albania and Macedonia 350
„ „ „ Australia 225, 490
„ „ „ Canada 368

PAGE

Coal deposits of Madagascar .. 371
,, ,, ,, Natal .. 488
,, ,, ,, Nigeria .. 224
,, ,, ,, Somaliland .. 201, 490
,, ,, ,, Szechuan .. 87
Coal into Oils, The Conversion of .. 546
Coal Tar, The Constituents of .. 416
Cobalt ore deposits of Queensland .. 491
Coconut, dwarf, character of .. 67
,, , epidemic disease in Trinidad .. 68
,, industry of British Guiana .. 358
,, , Mahali disease in Malabar .. 67
,, , red stripe weevil .. 207
,, , suggested research scheme in Ceylon .. 64
,, , variation in relation to fruit production .. 208
,, (*see also* Copra)
Cod-liver oil, Newfoundland .. 468
Coffee .. 529
Coffee bug .. 476
,, industry of Haiti .. 476
,, industry of Netherland East Indies .. 53
,, pest, *Stephanoderes coffeæ* in Brazil .. 61, 354
Constituents of Coal Tar, The .. 416
Construction of Wells and Bore-holes for Water Supply and the Elements of the Analysis and Purification of Water .. 272
Copper : A Survey of the Sources from whence the Metal is Obtained, the Methods of its Manufacture, the Nature of its Uses and the Conditions of the Trade .. 543
Copper-nickel ore deposits of Tasmania .. 499
Copper ore deposits of Albania and Macedonia .. 350
,, ,, ,, ,, Australia .. 372
,, ,, ,, ,, Belgian Congo .. 229
,, ,, ,, ,, Canada .. 90, 228, 372, 491
,, ,, ,, ,, Northern Rhodesia .. 88
,, ,, ,, ,, United States .. 90, 230
Copper, The Story of .. 414
Copra from Dominica .. 280
,, industry of Netherland East Indies .. 54
,, , methods of manufacture in the Philippines .. 65
Coral deposits of Ceylon .. 446
,, ,, ,, Straits Settlements .. 433
Cotton, acromania or crazy-top of Pima cotton in Arizona .. 79
,, , American varieties in Southern Nigeria .. 217
Cotton-Cellulose : Its Chemistry and Technology .. 127
Cotton, community cultivation of one variety in the United States 80
,, , co-operative marketing in the United States .. 80
,, , crinkle disease in Nigeria .. 218
,, grading in Sudan, South Africa and Queensland .. 213
Cotton-growing in French Colonies .. 71
,, ,, ,, Iraq .. 362

PAGE
Cotton-growing in Nyasaland 73, 479
" " " Peru 480
" " " Queensland 74, 363
" " " Salvador 76
" " " Tanganyika 77
" " " Victoria 81
Cotton industry of India 341
" " " Indo-China 346
Cotton in South Africa 124
Cotton, length of fibre from bolls at different heights on the plant 83
" periodicals, new 57
" , Pima, cultivation in Arizona 81
" , pink boll-worm in Egypt 361
" rain-grown 82
" , ratooned, quality of 74
" , ratooning in Queensland 364
" , ratooning trials in Egypt 215
" , red boll-worm (*Diparopsis castanea*) in Nyasaland .. 73
" research scheme for the British Empire 454
" stainers (*Dysdercus* spp.), control in Trinidad 82
" , summaries of recent work on .. 71, 213, 361, 479
Cotton, The Heritage of 528
Cotton varieties, changes in character due to cultivation in new countries 72
" , variety trials in Iraq 216
" , yellow stain disease (*Eremothecium* sp.) in Tanganyika .. 78
COUSEN, A. (*see* HODKIN, F. W.)
COX, J. F., *Crop Production and Soil Management* 527
CRAWFORD, M. D. C., *The Heritage of Cotton* 528
Crop Production and Soil Management 527
Crop Production in India 123
CRUMP, N. E., *Copper* 543
Cryptostegia grandiflora rubber 212
CUNDALL, F., *Jamaica in 1924* 122
CUNNINGHAM, B., *Port Administration and Operation* 273
Cyprus, asbestos deposits of 485
" , cement-making materials 449
" , ground-nut cultivation 323
" , *Origanum Maru* oil from 426

Dasheen 207
DAVIDSON, W. B., *Gas Manufacture* 131
DAVIES, W., *The Story of Copper* 414
DAWSON, W. H., *South Africa : Peoples, Places and Problems* .. 524
Diamonds in Tanganyika 502
Diseases, Gold Coast Plant 537
Distillation, Industrial, Principles and Practice of 533
Distillation, Low Temperature 547
Dominica, camphor from 275

PAGE
Dominica, copra from 280
„ , ginger from 276
„ , gommier resin from 278
„ , vanilla from 277
Douglas, C. E., *Rice : Its Cultivation and Preparation* .. 530
Dugong oil from Australia 429
Dumbleton, J. E., *The Construction of Wells and Bore-holes for Water Supply and the Elements of the Analysis and Purification of Water* 273
Dunn, L. C. (*see* Sinnott, E. W.)

Eames, A. J., and MacDaniels, L. H., *Introduction to Plant Anatomy* 539
East Kent Regional Scheme Preliminary Survey 549
Egusi seeds from Sierra Leone 153
Egypt, ratooning of cotton in 215
Elements of Forestry 128
Elengi bark, tanning properties 158, 160, 165
Emerson, P., *Soil Characteristics : A Field and Laboratory Guide* 527
Enemies of Timber 536
Engineering Geology 412
English-Speaking Nations, The 122
Essential oils, cultivation in France.. 356
„ „ , summaries of recent work on 212, 356

Falkland Islands, The 120
Federated Malay States, medang losoh (*Cinnamomum parthenoxylon*) oil from 428
„ „ „ , red stripe weevil of coconut in .. 207
„ „ „ , tin ore deposits of 102
Feeds, Commercial 531
Fibre, flax 219, 365, 481
„ , hemp 222
„ , henequen 17
„ , jute 222
„ , Manila hemp 223
„ , sisal hemp 17, 84, 483
Fibres, summaries of recent work on .. 71, 213, 361, 479
Field, S., and Bonney, S. R., *The Chemical Colouring of Metals and Allied Processes* 548
Fiji Islands, cement-making materials 45
„ , ground-nut cultivation 322
Flax, experiments in Canada 219
„ „ „ Iraq 481
Flax-growing in United Kingdom 365
Flax industry of Kenya 219
„ , possibility of producing in South Africa 220
Food, Scientific Preservation of 270

PAGE
Foodstuffs, summaries of recent work on .. 59, 205, 352, 473
Forest conservation in Canada 460
Forestry, Elements of 128
Forestry in North Borneo 50
FOSTER, SIR W., *The English Factories in India*, 1665–1667 .. 523
France, potash deposits of 243
FUCHER, F., *The Conversion of Coal into Oils* 546

Gambia, ground-nut cultivation 315
GARBE, J. B. (*see* NORTH, S. H.)
Gas Manufacture 131
GAVRON, J. L. (*see* RAIZISS, G. W.)
Genetics, Principles of 539
Geology, Engineering 412
Geology, Physical, An Introduction to, with Special Reference to North America 411
GILLETT, H. W., and MACK, E. L., *Molybdenum, Cerium and Related Alloy Steels* 542
Ginger from Dominica 276
Glass Technology, A Textbook of 271
GODDARD, T. W., *The Handbook of Sierra Leone* 265
Gold Coast, development of oil palm industry in 69
,, ,, , ground-nut cultivation 316
,, ,, , neele seeds (*Citrullus vulgaris*) from 150
Gold Coast Plant Diseases 537
Gold deposits of Australia 232, 376
,, ,, ,, Canada 91, 230, 373, 493
,, ,, ,, New Zealand 235, 498
,, ,, ,, Southern Rhodesia 90
,, ,, ,, Tanganyika 492
,, ,, ,, Transvaal 493
,, ,, ,, United States 94, 236, 376
,, industry of South Africa 49
Gommier resin from Dominica 278
GROOTHOFF, A., *De Kinacultuur* 531
Ground-nut, article on cultivation, preparation and utilisation .. 291
,, cake 328
,, , climatic conditions 294
,, , decortication 303
,, , description of plant 292
,, , extent of cultivation 291
,, germs 330
,, , harvesting 300
,, hay 302
,, husks 329
,, industry of Australia 68
,, manures 297
,, , oil, characters and uses 328
,, ,, , preparation 325

PAGE
Ground-nut, pests and diseases 309
„ , picking 303
„ , preparation of soil 296
„ , production in British Empire 311
„ skins 330
„ , soil 295
„ , sowing 298
„ , utilisation 323
„ , varieties 305
„ , yield 304
Guano deposits of Mait Island, British Somaliland 202
Guna seeds from Nigeria 155

HALL, A. J., *Cotton-Cellulose : Its Chemistry and Technology* .. 127
Handbook of British Honduras 525
Handbook of Sierra Leone 265
Handbook of Western Samoa 526
HAUSBRAND, E., *Principles and Practice of Industrial Distillation* 533
Hemp industry of Canada 222
„ , Manila (*see* Manila hemp)
„ , Sisal (*see* Sisal hemp)
Henequen fibre industry of Mexico.. 17
„ , Mexican, climate and soil 20
„ , „ , cost of production 26, 29
„ , „ , cultivation 20
„ , „ , extraction of fibre 23
„ , „ , harvesting 22
„ , „ , pests 22
„ , „ , production and exports 26
„ , „ , varieties 18
Hevea brasiliensis (*see* Para rubber)
HINDORF, R., *Der Sisalbau in Deutsch-Ostafrika* 408
HODKIN, F. W., and COUSEN, A., *A Textbook of Glass Technology* 271
Honey-bee, Anatomy and Physiology of the 411
Hong Kong, cement-making in 447
Hopea parviflora bark, tanning properties 159, 162
HOVELL, M., *Rats and How to Destroy Them* 131
HOWARD, A., *Crop Production in India* 123
Hyparrhenia glauca, paper-making experiments in South Africa 224

Illipe fat, extraction in North Borneo 51
Imperial Institute Act, 1925 195
„ „ , Advisory Committee 453
„ „ , Advisory Council on Minerals 452
„ „ , Board of Governors 451
„ „ exhibits at British Empire Exhibition .. 196
„ „ , general information i
Imperial Institute Monographs on Mineral Resources : Bauxite and Aluminium 196

PAGE

Imperial Institute Monographs on Mineral Resources, Bismuth Ores and *Antimony Ores* 47
Imperial Institute, reorganisation 451
India, cotton industry of 341
India, Crop-Production in 123
India, ground-nut cultivation 311
„ , iron ore deposits of Mysore 94
„ , *Juniperus communis* berry oil 213
„ Mahali disease of coconuts in Malabar 67
„ , stem rot disease of jute in 222
„ tanning materials from Travancore 158
„ „ properties of *Lagerstrœmia* spp. 84
„ , „ „ „ mangroves of South Tenasserim .. 85
„ , tea industry 63
India, The English Factories in, 1665–1667 523
India, The Making of 522
India, vegetable oil industry of the Punjab 471
„ , *Zanthoxylum* spp. oil 213
Indian pulp and paper industries 466
Indo-China, cotton industry of 346
„ , lianes from, for paper-making 366
Introduction to Physical Geology, with Special Reference to North America 411
Iraq, cotton-growing in 216, 362
„ , flax experiments in 481
„ , ground-nut cultivation 314
Ireland, bauxite deposits of 486
Iron ore deposits of Albania and Macedonia 350
„ „ „ Australia 237
„ „ „ Mysore 94
„ „ „ Philippines 377
Ivory Coast, avodiré wood (*Turrœanthus africana*) for paper-making 482

Jamaica, cement-making materials 33
Jamaica in 1924 122
Japan, petroleum in 382
Jasmine oil, production in France 356
Jeffrey, E. C., *Coal and Civilisation* 415
Juniperus communis berries, essential oil 213
Jute, stem rot disease (*Macrophoma Corchori*) in India 222

Kakao 406
Kareencha bark, tanning properties 159, 162, 167
Kawang fat, extraction in North Borneo 51
Kent-Jones, D. W., *Modern Cereal Chemistry* 126
Kenya 121
Kenya, flax industry of 219

PAGE
Kenya, ground-nut cultivation 318
,, , tea production in 62
Kikuyu grass (*Pennisetum clandestinum*) in New Zealand .. 355
Kinacultuur, De 531
KLAR, M., *The Technology of Wood Distillation* 409
Kogai seeds from Sierra Leone 153
KYLE, E. J. (*see* STUCKEY, H. P.)

LADOO, R. B., *Non-Metallic Minerals. Occurrence—Preparation —Utilisation* 414
Lagerstrœmia spp. of Burma, tanning properties 84
LANGTON, H. M., *Blacks and Pitches* 548
Lead ore deposits of Albania and Macedonia 351
,, ,, ,, British Somaliland 202
Leeward Islands, cement-making materials 40
LEVY, S. I., *The Rare Earths, their Occurrence, Chemistry and Technology* 270
LEYS, N., *Kenya* 121
Lianes of Indo-China for paper-making 366
Lignite deposits of British Somaliland 201
,, ,, Nigeria 202
Limestone deposits of Bahamas 42
,, ,, ,, Barbados 41
,, ,, ,, Bermuda 44
,, ,, ,, British Honduras 42
,, ,, ,, Ceylon 441
,, ,, ,, Federated Malay States 432
,, ,, ,, Fiji Islands 45
,, ,, ,, Jamaica 33
,, ,, ,, Leeward Islands 40
,, ,, ,, North Borneo 434
,, ,, ,, Palestine 448
,, ,, ,, Sarawak 439
,, ,, ,, Straits Settlements 433
,, ,, ,, Trinidad 39
Lithium ore deposit in Manitoba 498
LUKE, H. C., *A Bibliography of Sierra Leone* 525
LYDE, L. W., *The Oxford Economic Atlas* 266

Macadamia ternifolia (Queensland nut), planting in Hawaii and character of oil 358
MACINNES, C. M., *The British Commonwealth and its Unsolved Problems* 404
MCKEE, R. H., *Shale Oil* 545
MACMILLAN, H. F., *Tropical Gardening and Planting, with Special Reference to Ceylon* 416
Madagascar, coal deposits of 371
Magnesite deposits of Manchuria 95

PAGE

Malaya, cement-making materials 431
„ , ground-nut cultivation 312
„ , oil-palm insects of 477
Malayan Trade Annual, 1925 524
Malta, cement-making materials of 451
Manganese ore deposits of Albania and Macedonia 351
„ „ „ „ the Philippines 378
Manganese Ore with Special Reference to Georgian Ore 541
Mangroves of South Tenasserim, tanning properties 85
Manila hemp, causes of deterioration 223
MANINGTON, G., *The West Indies* 405
Marketing of Metals and Minerals, The 412
MARTINDALE, W. M., and WESTCOTT, W. W., *The Extra Pharmacopœia, Vol. II* 532
Massoi bark from Papua 423
Mauritius, ground-nut cultivation 323
Medang losoh oil from the Federated Malay States 428
MELL, C. D. (*see* RECORD, S. J.)
Métallurgie du Cuivre et Alliages de Cuivre 543
Metallurgy for Engineers, A Course of 544
Metallurgy of Aluminium and Aluminium Alloys, The 413
Metals and Minerals, The Marketing of 412
Mexico, henequen or sisal hemp industry of 17
Mica deposits of British Somaliland 202
MILLER, W. J., *An Introduction to Physical Geology, with Special Reference to North America* 411
Mimusops Elengi bark, tanning properties 158, 160, 165
Mineral resources of Albania and Macedonia 349
„ „ „ British Somaliland 200
Minerals, Non-Metallic : Occurrence—Preparation—Utilisation .. 414
Minerals, summaries of recent work on .. 86, 224, 368, 485
Modern Cereal Chemistry 126
Molybdenum, Cerium and Related Alloy Steels 542
Monazite deposits of Tasmania 238
„ occurrence in Transvaal 499
Monkey apple timber (*Anisophyllea laurina*) from Sierra Leone, description, mechanical and working tests 8
MOON, F., and BROWN, N. C., *Elements of Forestry* 128
Mora bark, tanning properties 158, 161
MORRIS, G. W., and WOOD, L. S., *The English-Speaking Nations* 122
Mozambique, sisal hemp growing in 484
Munga perzhu bark, tanning properties 158, 161

Nachschlagebuch der Nachschlagewerke für die Wirtschaftspraxis 551
Nature Teaching 539
Neele seeds from Gold Coast 150
Netherland East Indies, agriculture in 51
„ „ „ , tea industry 205
Newfoundland cod-liver oil 468

PAGE
New Zealand, chrysotile asbestos in 86
„ „ , gold deposits of 235, 498
„ „ , petroleum in 240, 501
Nickel-copper ore deposits of Tasmania 499
Nickel ore deposits of South Africa 238
Nigeria, coal deposits of 224
„ , cotton experiments in 217
„ , development and resources.. 331
„ , ground-nut cultivation 316
„ , guna seeds (*Citrullus vulgaris*) from 155
„ , new lignite deposits of 202
Nipa palm, alcohol from 50, 175
Non-Metallic Minerals: Occurrence—Preparation—Utilisation .. 414
North America 406
North America, An Introduction to Physical Geology with Special Reference to 411
North Borneo, alcohol from nipa palm in 50, 175
„ „ , cement-making materials 434
„ „ , forestry in 50
North, S. H., and Garbe, J. B., *Low Temperature Distillation* .. 547
Notices of recent literature 120, 265, 404, 522
Nyasaland, bauxite deposits of 486
„ , clays for the manufacture of bricks, tiles, drain-pipes and pottery 281
„ , cotton-growing in 73, 479
„ , ground-nut cultivation 317

Ochna pulchra fruits from Rhodesia 1
Ochroma Lagopus wood from British Honduras, characters and working properties .. 4
„ „ „ „ „ „ paper-making trials .. 14
Official Year Book of the Colony of Southern Rhodesia, No. 1, 1924 266
Oil-cake, *Citrullus vulgaris* 151, 154, 157
„ , ground-nut 328
„ , *Ochna pulchra* 2
Oil, essential, camphor leaves and twigs 421
„ „ , *Citrus* 212
„ „ , cultivation in France.. 356
„ „ , jasmine 356
„ „ , *Juniperus communis* berries 213
„ „ , massoi bark (*Cinnamomum Massoia*) 423
„ „ , medang losoh (*Cinnamomum parthenoxylon*) .. 428
„ „ , *Origanum Maru* 426
„ „ , *Zanthoxylum* spp. 213
„ , fixed, babassu 357
„ „ , Chinese wood oil 476
„ „ , *Citrullus vulgaris* (egusi, guna, kogai or neele seed) .. 149

PAGE
Oil, fixed, cod-liver 468
„ , „ , dugong 429
„ , „ , ground-nut 324
„ , „ , *Macadamia ternifolia* (Queensland nut) 358
„ , „ , *Ochna pulchra* 1
„ , mineral (*see* Oil Shale and Petroleum)
„ palm cultivation in Netherland East Indies 54
„ „ , development of industry in Gold Coast 69
„ „ , germination trials 210
„ „ , hispid leaf miner (*Cœlœnomenodera Elæidis*) in Gold Coast 359
„ „ , insects of in Malaya 477
„ „ , investigations on ripening of fruits 478
„ „ , report of Colonial Office Committee 358
„ „ , selection 205, 360
Oil-shale deposits of Canada 378
„ „ „ „ New South Wales 97, 500
„ „ „ „ Somerset 96
„ „ „ „ Tasmania 500
Oil, vegetable, industry of the Punjab 471
Oils and oil seeds, summaries of recent work on 63, 207, 357, 476
Orbignia Martiana (see *Attalea speciosa*)
Organic Arsenical Compounds 130
Organic Derivatives of Antimony 410
Origanum Maru oil from Cyprus 426
Oxford Economic Atlas, The 266

Palestine, cement-making materials 448
„ , potash from waters of the Dead Sea 502
Palladium-mercury occurrence in British Guiana 239
Paper-making materials, *Alstonia congensis* wood 307
„ „ , avodiré wood (*Turræanthus africana*) .. 482
„ „ , balsa or polak wood 14
„ „ , Indian 467
„ „ , lianes from Indo-China 366
„ „ , pulp-wood in Canada 455
„ „ , quam wood (*Schizolobium* sp.) .. 13
„ „ , Sorghum stalks 366
„ „ , tambookie grass (*Hyparrhenia glauca*) .. 223
„ „ , white Moho (*Hibiscus* sp.) 13
Paper making, proposed pulp mill in North Borneo 50
„ production in Canada 458
„ „ in India 466
Papua, massoi bark from 423
Para rubber, Ceylon research scheme, report on work 197
„ „ , „ „ „ investigations conducted under 135
„ „ , from latex preserved with ammonia 211
„ „ , methods of testing employed at Imperial Institute 146

PAGE
Para rubber, packing 211
„ „ , South American leaf disease 211
„ „ , variability of vulcanising and mechanical properties of plantation rubber 135
Paraffin dirt 240
Parry's Cyclopædia of Perfumery 268
PEARSON, H. P., *Waterproofing Textile Fabrics* 127
Pecan-growing 407
Pennisetum clandestinum (Kikuyu grass) in New Zealand .. 355
Perilla seed cultivation in United States 478
Peru, cotton-growing in 480
Perzhu bark, tanning properties 158, 160, 165
Petroleum in Albania and Macedonia 351
„ „ Argentina 98
„ „ Canada 379
„ „ Japan 382
„ „ New Zealand 240, 501
„ „ Rumania 380
„ „ Russia 241
„ „ Trinidad 97
„ „ United States 242
Pharmacopœia of Martindale and Westcott, The Extra, Vol. II .. 532
Phaseolus acutifolius beans, digestibility 355
Philippines, iron ore deposits 377
„ , manganese ore deposits 378
Phytophthora omnivora var. *Arecæ*, cause of Mahali disease of coconuts 67
Plant Anatomy, Introduction to 539
Platinum and gold in the Transvaal 48
„ deposits of the Transvaal 48, 204, 501
Polak wood from British Honduras, characters and working properties 5
„ „ „ „ „ paper-making trials .. 14
Port Administration and Operation 273
Portland cement, revised British Standard Specification .. 472
Potash deposits of France 243
„ „ „ Spain 243
„ „ „ United States 244
„ from waters of the Dead-Sea 502
PRINSEN-GEERLIGS, H. C., *Cane Sugar and its Manufacture* .. 126
„ „ „ *Zuckerrohr* 530
Pterocarpus Marsupium bark, tanning properties .. 159, 163
Pulp production in India 466
Pulp-wood situation in Canada 455

Quam wood (*Schizolobium* sp.) paper-making trials 13

Radio-active ore deposits of South Australia 503
RAIZISS, G. W., and GAVRON, J. L., *Organic Arsenical Compounds* 130

PAGE
Rare Earths, their Occurrence, Chemistry and Technology .. 270
Rats and How to Destroy Them .. 131
Record, S. J., and Mell, C. D., *Timbers of Tropical America* .. 534
Rector, T. M., *Scientific Preservation of Food* .. 270
Réunion, L'Ile de la .. 526
Rhodesia, ground-nut cultivation .. 319
,, , *Ochna pulchra* fruits from .. 1
,, , Northern, copper deposits .. 88
,, , Southern, gold deposits of .. 90
Rice borer, white, in Java .. 475
Rice : Its Cultivation and Preparation .. 530
Rice, world's production and consumption .. 474
Ries, H., and Watson, T. L., *Engineering Geology* .. 412
Rubber, *Cryptostegia grandiflora* .. 212
,, , *Hevea brasiliensis* (*see* Para rubber)
,, industry of Netherland East Indies .. 52
Rumania, petroleum in .. 380
Russia, petroleum in .. 241

Samoa, Western, Handbook of .. 526
Samoa, Western, sale of Government Crown estates in .. 58
Sarawak, cement-making materials .. 439
Scherffius, W. H., and Oosthuizen, J. du P., *Cotton in South Africa* .. 124
Scientific Preservation of Food .. 270
Scotland, sugar-beet growing in .. 474
Seasoning and Preservation of Timber, The .. 269
Shale Oil .. 545
Shea nuts, proposed factory for treating in French Sudan .. 479
Sierra Leone, A Bibliography of .. 525
Sierra Leone, kogai or egusi seed (*Citrullus vulgaris*) from .. 153
Sierra Leone, The Handbook of .. 265
Silver-lead ore deposits of Transvaal .. 99
Silver ore deposits of Australia .. 244
,, ,, ,, ,, Canada .. 100
,, ,, ,, ,, Spain .. 102
,, ,, ,, ,, United States .. 245, 383
Sinnott, E. W., and Dunn, L. C., *Principles of Genetics* .. 539
Sisalbau in Deutsch-Ostafrika, Der .. 408
Sisal hemp, experiments in Ceylon .. 483
,, ,, growing in Mozambique .. 484
,, ,, industry of the Caicos Islands .. 84
,, ,, ,, ,, Mexico .. 17
,, ,, ,, ,, Tanganyika .. 84
Smith, J. R., *North America* .. 406
Snodgrass, R. E., *Anatomy and Physiology of the Honey-bee* .. 411
Soil Acidity and its Relation to the Production of Nitrate and Ammonia in Woodland Soils .. 129
Soil Characteristics : A Field and Laboratory Guide .. 527

PAGE
Soil Management 129
Somaliland, coal deposits of 490
„ , mineral resources of 200
Sorghum stalks for paper-making 366
South Africa, Cotton in 124
South Africa : People, Places and Problems 524
South African Engineering and Mining Journal, Year Book and Directory of 272
Southern Rhodesia, Official Year Book of the Colony of, No. 1, 1924 266
Spain, potash deposits of 243
„ , silver ore deposits of 102
SPIELMANN, P. E., *Bituminous Substances* 547
„ „ *The Constituents of Coal Tar* 416
SPURR, J. E., and WORMSER, F. E. (eds.), *The Marketing of Metals and Minerals* 412
STAMP, L. D., *The Vegetation of Burma from an Ecological Standpoint* 538
Story of Copper, The 414
STROWD, W. H., *Commercial Feeds* 531
STUCKEY, H. P., and KYLE, E. J., *Pecan-growing* 407
Sudan, cotton grading in 213
„ , ground-nut cultivation 318
Sugar, beet, de Vecchis process 352
„ „ , enlargement of factory at Maffra, Victoria .. 60
„ „ , industry in Western Canada 60
„ „ , prospects of growing in Scotland 474
„ cane industry of Netherland East Indies 51
„ „ , loss due to mosaic disease 473
„ „ , production and prospects in Uganda .. 59
„ maple, industry of Canada 61
Sweet potato, storage 353

Tambookie grass (*Hyparrhenia glauca*) paper-making experiments in South Africa 224
Tanganyika, cotton-growing in 77
„ , diamonds in 502
„ , gold deposits of 492
„ , ground-nut cultivation 317
„ , sisal hemp industry 84
Tanning materials, *Acacia pennata* (kareencha) bark .. 159, 162, 167
„ „ , *Albizzia Lebbek* (vaga) bark .. 158, 161, 166
„ „ , *Buchanania latifolia* (mora or munga perzhu) bark 158, 161
„ „ , *Careya arborea* (perzhu) bark .. 158, 160, 165
„ „ from Travancore 158
„ „ *Hopea parviflora* (thambagom) bark 159, 162
„ „ , *Lagerstrœmia* spp. 84
„ „ mangroves of South Tenasserim 85
„ „ *Mimusops Elengi* bark 158, 160, 165

PAGE
Tanning materials, *Pterocarpus Marsupium* (venga) bark 159, 163
„ „ , *Terminalia tomentosa* (thembavu) bark 159, 163
Taros 207
TAYLOR, H. W., *Tobacco Culture with Special Reference to South African Conditions* 125
Tea industry of India 63
„ „ „ Netherland East Indies 53, 205
„ , mosquito blight pest, in Java 62
„ production in Kenya 62
„ , shot-hole borer, control of in Ceylon 475
Technology of Wood Distillation, The 409
Tepary bean (*Phaseolus acutifolius*), digestibility 355
Terminalia tomentosa bark, tanning properties .. 159, 163
Textbook of Glass Technology, A 271
Thambagom bark, tanning properties 159, 162
Thembavu bark, tanning properties 159, 163
THOMAS, S., *Bacteriology, A Textbook on Fundamentals* .. 540
THOMPSON, F. C., *A Course of Metallurgy for Engineers* .. 544
Timber, balsa or polak 4, 14
Timber, Enemies of 536
Timbers of Tropical America 534
Timber, The Seasoning and Preservation of 269
Tin ore deposits of Federated Malay States 102
Tobacco Culture with Special Reference to South African Conditions 125
Tobacco industry of Netherland East Indies 53
Trinidad, cement-making materials 38
„ , epidemic disease of coconuts in 68
„ , petroleum in 97
Tropical Gardening and Planting, with Special Reference to Ceylon 416

Uganda, camphor leaves and twigs from 421
„ , ground-nut cultivation 318
„ , sugar production and prospects in 59
Union of South Africa, chromium ore deposits of Transvaal .. 487
„ „ „ „ , coal deposits of Natal 488
„ „ „ „ , cotton grading in 213
„ „ „ „ , gold deposits of Transvaal .. 48, 493
„ „ „ „ , ground-nut cultivation 319
„ „ „ „ , monazite occurrence in Transvaal .. 499
„ „ „ „ , nickel ore deposits of.. 238
„ „ „ „ , paper-making experiments with tambookie grass (*Hyparrhenia glauca*) .. 224
„ „ „ „ , platinum in Transvaal .. 48, 204, 501
„ „ „ „ , possibilities of flax industry in 220
„ „ „ „ , silver-lead ore deposits of Transvaal .. 99
United States Bureau of Plant Industry, work of 55
„ „ , copper deposits 90, 230
„ „ , gold deposits of 94, 236, 376
„ „ , petroleum in 242

PAGE
United States, potash deposits of 244
„ „ , silver ore deposits of 245, 383

Vaga bark, tanning properties 158, 161, 166
Vanilla from Dominica 277
Vegetation of Burma from an Ecological Standpoint 538
Venga bark, tanning properties 159, 163

WALTER, K., *Agricultural Co-operation in the British Empire* .. 267
Waterproofing Textile Fabrics 127
Water, The Construction of Wells and Bore-holes for Water Supply and the Elements of the Analysis and Purification of .. 272
WATSON, T. L. (*see* RIES, H.)
WATTS, SIR F., *Nature Teaching* 539
Wheat experiments in Canada 206
White moho (*Hibiscus* sp.), paper-making trials 13
Weihaiwei, ground-nut cultivation 313
West Indies, ground-nut cultivation 323
West Indies, The 405
West Indies (*see also* separate Islands)
WIEMAN, H. L., *General Zoölogy* 541
Wood Distillation, The Technology of 409
WOOD, L. S. (*see* MORRIS, G. W.)
Wood oil, Chinese, cultivation of trees in Florida 476
WORMSER, F. E. (*see* SPURR, J. E.)

Yautias 207
Year Book and Directory of the South African Engineering and Mining Journal 272

Zanthoxylum spp., essential oil 213
ZELLER, T., *Kakao* 406
ZERETELI, D., *Manganese Ore with Special Reference to Georgian Ore* 541
Zinc ore deposits of Albania and Macedonia 351
Zoölogy, General 541
Zuckerrohr 530

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